

# THE ADULT TAENIOID CESTODES OF DOGS AND CATS, AND OF RELATED CARNIVORES IN NORTH AMERICA.

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## INTRODUCTION AND SUMMARY.

The literature bearing on the subject of tapeworms parasitic in dogs and other carnivores is extensive, but because it is scattered in numerous papers the student of these forms is likely to experience considerable difficulty in the determination of specimens, particularly in the case of tapeworms from wild carnivores. Heretofore there has not been available a comprehensive discussion of the subject in a single paper.

The present paper includes descriptions of all the adult tapeworms of the superfamily Taenioidea known to occur in dogs, cats, and related carnivores in North America, together with species of the same superfamily not yet recorded as present in North America, but found in other parts of the world, and liable to occur in carnivores in this country. Supplementing the descriptions are keys for the determination of specimens, a list of hosts, and a bibliography.

The illustrations, whether original or copied, were made by Mr. W. S. D. Haines, artist of the United States Bureau of Animal Industry.

*Lynx vinta* is recorded as a new host for *Taenia taeniaeformis*. *Taenia macrocystis* is newly recorded for North America, having been collected from *Lynx ruffus* and *L. baileyi*. *Taenia pisiformis* (larval stage) is newly recorded from *Lepus californicus wallawalla*, *Sylvilagus floridanus mearnsii*, *S. auduboni baileyi*, and mountain beaver. *Taenia novella* Neumann, 1896, is regarded as synonymous with *T. pisiformis* instead of with *T. laticollis* as Lühe (1910) believed. *Taenia pisiformis* frequently shows more than the 8 to 10 lateral uterine branches commonly stated in the literature as characteristic of this species. As many as 14 may be present.

New hosts for *Taenia hydatigena* are the Bharrel (National Zoological Park), Columbia deer, *Odocoileus hemionus*, *Rangifer terrae-*

*novae*, *Alces alces*, *Ovis mexicana*, and *Odocoileus americanus*. Contrary to the statement commonly made in descriptions of this species placing the limits of the number of lateral uterine branches between 5 and 8, as many as 10, and even more, may be found

#### TAXONOMY AND MORPHOLOGY.

### Phylum PLATYHELMINTHES.

*Phylum diagnosis.*—Worms which are flattened dorso-ventrally and are bilaterally symmetrical. No body cavity present. Digestive cavity present or absent; when present, incomplete—that is, with an initial mouth aperture but without a terminal anal aperture, except in the Nemertinea. Organs and systems of body embedded in a parenchymatous tissue. Muscular systems well developed. Nervous system consisting of an anterior nerve ring, surrounding the esophagus when the latter is present, and of longitudinal nerves, with ganglia, passing caudad and sending off branches. Skeletal system not represented, although calcareous corpuscles are commonly present in the body parenchyma of the Cestoda. These probably have little or no skeletal function. Circulatory system not represented. Respiration cutaneous. Excretory system consists of two or more longitudinal or coiled tubes, with terminal openings to the exterior and ultimate origins in nephridial flame-cells. Reproduction sexual or asexual, and development direct or with alternation of generations.

#### Class CESTODA.

*Class diagnosis.*—Platyhelminthes: Worms with external segmentation, exceptionally without, and with internal anatomy showing segmental arrangement and commonly arranged with reference to the external segmentation. At one end is a structure called the head, but variously regarded by writers as actually an anterior cephalic structure, or as a posterior pedal structure. This is essentially an organ of attachment and is provided with two suckorial grooves or bothridia, or with four more or less cuplike depressions or suckers. There may also be one to numerous crowns of hooks on a muscular apex or rostellum in forms with four suckers, and also on the suckers themselves in these forms. The body segments are smallest near the head. No digestive system present; food absorbed by osmosis through the body surface. Body parenchyma usually contains numerous calcareous corpuscles scattered through it. Nervous system consists of a nerve ring located in the head and sending two main nerve systems back on each side of the body or strobila, and of the nerves extending from the ring and the lateral nerve trunks and

ganglia. The excretory system consists, commonly, of a dorsal and a ventral excretory vessel on each side of the strobila with a simple or elaborate set of vessels connecting the vessels of the same side or of opposite sides. The main longitudinal vessels terminate in openings in the posterior extremity of the strobila and receive waste matters poured in from canaliculi originating in flame-cells in the parenchyma. With rare exceptions, the strobila is hermaphroditic, the male and female sex organs being represented in each segment. The eggs, or, more properly, embryophores, develop in the segments to form an onchosphere armed with three pairs of hooks and surrounded by one or several membranes, or they are similar to fluke eggs, often with an operculum, do not contain an embryo when they escape from the segments, and later develop an onchosphere with a surrounding covering of cilia. Development always involves an alternation of generations, the intermediate stage, in the form of a bladderworm of some sort and with the developed head of the adult as the essential structure and a surrounding membrane of some sort as the incidental structure, developing in an intermediate host. This larval stage develops to the adult worm on ingestion by a suitable host.

### Superfamily TAENIOIDEA Zwicke, 1841.

*Synonym.*—Cyclophyllidea van Beneden.

*Superfamily diagnosis.*—Cestoda: Head or scolex with four cup-shaped suckers which may exceptionally (Tetrabothriidae) bear auricular appendages, or exceptionally (Fimbriariidae) with a pseudo-scolex in place of this scolex. Apical rostellum present or lacking. Suckers and rostellum may be armed with hooks or unarmed. Neck present or lacking. Strobila with well-developed segmentation, or exceptionally (Fimbriariidae) without division into segments. A single series of reproductive organs or a complete or incomplete double series, both male and female organs present in the same segments except in *Dioicocestus* where the strobilae are, respectively, male or female. Genital pores usually present and marginal, exceptionally ventral (Mesocestoididae), or lacking (Aporina). Testes usually numerous, occasionally as few as two, and in medullary portion of segment. Ovary more or less bilobed. Yolk gland compact, usually single and located near the median line. So-called shell-gland between ovary and yolk gland. Uterus without special opening for the discharge of eggs to the exterior, except that rarely a secondarily formed aperture may be present. Onchosphere with one or several membranes and without operculum. Larval stages in vertebrates or invertebrates. Adults in the alimentary canal of vertebrates.

*Type-family.*—Taeniidae Ludwig, 1886a.

In limiting the scope of this paper to a consideration of the taenioid cestodes, there have been excluded from consideration the carnivore

tapeworms belonging to the Proteocephalidae and the Diphyllbothriidae. The only species of Proteocephalidae reported from carnivores is *Ophiotaenia punica* (Kholodkovski, 1908) La Rue, 1911. This species was described from the dog by Kholodkovski (1908) as *Taenia punica*, but the present writer (Hall, 1910) pointed out that this should be transferred to the genus *Proteocephalus* and that it was presumably not a true parasite of the dog, but had been ingested by the dog in eating the true host, some fish, reptile, or batrachian. In his revision of the Proteocephalidae, La Rue (1911) created the new genus *Ophiotaenia* for the reptilian cestodes of that family, and transferred this species to the new genus. This species is evidently not to be considered as a parasite of carnivores and nothing would be gained so far as concerns the purposes of the present paper by a description of its morphology. The presence of follicular yolk glands in the lateral fields is one feature which distinguishes the Proteocephalidae from the Taenioidea.

The omission of the Diphyllbothriidae from this paper is of more importance than the omission of the Proteocephalidae. Species belonging in this group have been reported from carnivores in North America and material of the sort is available to the writer for study, but a casual examination of the material indicates that it would require more time for adequate study than can be given at present. This family is relatively much less important than the superfamily Taenioidea covered in this paper. Members of the Diphyllbothriidae are characterized by the presence of a rosette-shaped uterus which has a special aperture in the midventral line for the discharge of eggs.

The keys given deal with each taxonomic group, from families to the species of a given genus, separately. At the end of this paper is a key covering the species of all genera involved.

KEY TO THE FAMILIES OF TAENIOIDEA.

1. Genital pores located on the ventral surface near the median line. Eggs in gravid segments enclosed in a single thick-shelled egg capsule.
 

MESOCESTOIDIDAE, p. 59.

Genital pores lateral. Eggs in gravid segments contained in a uterus or in numerous egg capsules..... 2
2. Usually large forms. Genital pores irregularly alternate. Rostellum usually well developed and usually armed with a double crown of hooks, rarely with a single (?) crown of hooks or unarmed. Suckers unarmed. Uterus with a median stem and lateral branches. Eggs thick shelled—i. e., embryo surrounded by a thick embryophore.....TAENIIDAE, p. 51.
 

Usually small forms. Genital pores single or double; if single, regularly or irregularly alternate. Rostellum present or absent; if present armed with one to numerous rows of hooks. Suckers armed or unarmed. Uterus saclike and persistent or with one or several parauterine organs to which the eggs pass in the final stage of development. Eggs with thin transparent shells (i. e., embryo surrounded by thin transparent embryophores).

HYMENOLEPIDIDAE, p. 61.

## Family TAENIIDAE Ludwig, 1886a.

*Synonyms.*—Taeniadae Baird, 1853a; Taeniodea Diesing of Goldberg, 1855a; Taeniadea Carus, 1863; Teniadae Perrier, 1897a.

*Family diagnosis.*—Taenioidea: Rostellum usually well developed, rarely rudimentary, and usually armed with a double crown of hooks composed of a circlet of large hooks and a circlet of small hooks, the large and small hooks arranged alternately; rarely with a single (?) circlet of hooks or unarmed. Suckers unarmed. Gravid segments longer (that is, along the longitudinal axis of the strobila) than broad (that is, along the transverse axis of the strobila). A single set of reproductive organs in each segment with the genital pores irregularly alternate. Testes numerous. Ovary bilobed, or may be regarded as two ovaries. Uterus with a median stem and lateral branches and without an opening to the exterior for the escape of the eggs.

*Type-genus.*—*Taenia* Linnaeus, 1758.

## Subfamily TAENIINAE Stiles, 1896b.

*Synonyms.*—Taeniae Goldberg, 1855a; Cystotaeniae Claus, 1876; Taenianae Railliet, 1896.

*Subfamily diagnosis.*—Taeniidae: Usually large species. Gravid segments usually considerably longer than broad. Scolex with rostellum and usually armed with a double crown of hooks, rarely with a single (?) circlet of hooks or unarmed. Genital pores irregularly alternate. Testes usually very numerous, mostly in the lateral portions of the median field bordered by the longitudinal excretory canals and to a less extent in the median portion of this field. Ovary, shell-gland, and yolk-gland in the posterior portion of the median field, distal from the head. Uterus with a median stem from which develop lateral branches, the structure suppressing the genital glands, wholly or partly, in gravid segments. Of the four longitudinal excretory canals, usually only the ventral are readily visible in gravid segments. Egg shell thin, with or without filaments, usually disappears after a time; embryophore thick and radially striate. Intermediate larval stage a bladderworm of the cysticercus, coenurus, or echinococcus type, occurring in herbivorous or omnivorous animals. Adult stage a strobilate worm in carnivora or omnivora.

*Type-genus.*—*Taenia* Linnaeus, 1758a.

## KEY TO THE GENERA OF TAENIINAE.

1. Strobila less than 1 centimeter long and composed of a head and 3 segments, only one of the segments being gravid at a time. Lateral uterine branches often quite indistinct. Yolk-gland globular. Larval stage an echinococcus with thick laminated wall, and developing brood capsules containing the larval scolices.....*Echinococcus*, p. 56.

Strobila at least several centimeters long and composed of a head and numerous segments, from 10 to hundreds, with a number of segments usually gravid at one time. Lateral uterine branches usually distinct, at least in early stages of formation. Yolk-gland posterior of ovaries and elongate or triangular, with one side parallel to the posterior margin of the segment. Larval stage a bladderworm with thin walls, and never containing brood capsules.----- 2.

2. Handle of large hook usually sinuous; vagina usually shows a reflexed loop in the vicinity of the longitudinal excretory canals. Larva a coenurus—i. e., a bladderworm with a thin wall containing numerous scolices, and occasionally daughter bladders, but never brood capsules.---*Multiceps*, p. 39.
- Handle of large hook usually not sinuous; vagina straight or curved in the vicinity of the longitudinal canals, but without a reflexed loop at this point. Larva a cysticercus—i. e., a bladderworm containing one scolex.

*Taenia*, p. 6.

It appears difficult at the present time to write a key that will differentiate between the strobilate forms of the genus *Taenia* and those of the genus or subgenus *Multiceps*. This is not surprising. A coenurus for a larval stage may be regarded as a localized mechanical device for reproductive purposes and need not be expected to exert any noticeable effect on the strobilate morphology. It would naturally be expected that species of this genus would show relationship, but it would not necessarily follow that there would be a notable departure in structure from that of the parent genus, *Taenia*.

#### Genus TAENIA Linnaeus, 1758a.

*Synonyms*.—*Tenia* Scopoli, 1777; *Hydatigena* Goeze, 1782a; *Megcephalos* Goeze, 1782a; *Pseudoechinorhynchus* Goeze, 1782a; *Finna* Werner, 1786a; *Vesicaria* Mueller, 1787a; *Hydatula* Abildgaard, 1790; *Haeruca* Gmelin, 1790a; *Hydatis* Blumenbach, 1797; *Cysticercus* Zeder, 1800a; *Alyselminthus* Zeder, 1800a; *Halysis* Zeder, 1803a; *Cisticercus* Rudolphi, 1805a; *Physchiosoma* Brera, 1809a; *Finna* Brera, 1809a; *Goeziana* Rudolphi, 1810a; *Hydatigera* Lamarck, 1816; *Fischiosoma* delle Chiaje, 1825a; *Trachelocampylus* Frédault, 1847b; *Arhynchotaenia* Diesing, 1850a; *Halysis* Goldberg, 1855a; *Acanthotrias* Weinland, 1858a; *Cystotaenia* Leuckart, 1863; *Neotenia* Sodero, 1886a; *Neotaenia* Braun, 1894a; *Cysticerkus* of authors; *Cystizerkus* of authors.

*Generic diagnosis*.—Taeniinae: Rostellum distinct and armed with a double crown of hooks, or, exceptionally, with a single (?) crown of hooks. Strobila composed of from 10 to hundreds of segments. Usually large forms. Larva a cysticercus in mammals; adult strobila in meat-eating mammals.

*Type-species*.—*Taenia solium* Linnaeus. 1758a.

## KEY TO THE SPECIES OF TAENIA.

1. Rostellum with a single circlet of hooks of rose-thorn shape.  
*Taenia monostephanos*, p. 38.  
 Rostellum with a double crown of hooks of conventional shape, i. e., with a relatively long handle----- 2.
2. Large hooks 60 to 74 in number; 320 to 355  $\mu$  long; the large hooks arranged alternately nearer to the center of the rostellum and farther from it, forming, in effect, 2 circlets of large hooks-----*Taenia macrocystis*, p. 13.  
 Large hooks not over 60 in number----- 3.
3. No neck. Large hooks 380 to 420  $\mu$  long; hooks 26 to 52 in number, well-developed sphincter vaginae-----*Taenia taeniaformis*, p. 9.  
 Neck present, or if absent, large hooks 38 to 60 in number, no sphincter vaginae----- 4.
4. No neck. Large hooks 38 to 60 in number; 380 to 420  $\mu$  long.  
*Taenia laticollis*, p. 8.  
 Neck present. Large hooks not over 294  $\mu$  long----- 5.
5. Large hooks 225 to 294  $\mu$  long. Small hooks deeply bifid. Testes extend posterior of the vitellarium. Vas deferens originates in a vesicula seminalis-----*Taenia pisiformis*, p. 22.  
 Large hooks not over 220  $\mu$  long----- 6.
6. Guard of small hook twisted so that its flat surface tends to lie in the plane of the blade and handle-----*Taenia brachysoma*, p. 21.  
 Guard of small hook not so twisted----- 7.
7. Head acorn-shaped with hooks far anterior of the suckers. Mature segments approximately square-----*Taenia balaniceps*, p. 16.  
 Head not acorn-shaped and hooks not far anterior of the suckers. Mature segments distinctly broader than long----- 8.
8. Large hooks 95 to 140  $\mu$  long-----*Taenia brauni*, p. 19.  
 Large hooks 148  $\mu$  long or more (species of *Multiceps* will run down to here with a range of 135 to 180  $\mu$ )----- 9.
9. Gravid uterus with 20 to 25 lateral branches on each side of the median stem. Vagina crosses the ovary on the pore side in some segments.  
*Taenia ovis*, p. 32.  
 Gravid uterus with not over 10 lateral branches on each side. Vagina does not cross the ovary on the pore side of segments----- 10.
10. Large hooks 148 to 170  $\mu$  long. Genital papilla very large and prominent, practically as long as the margin of the segments. Vagina does not form a crescent near segment margin. Gravid segments without a median longitudinal groove terminating in a posterior notch.  
*Taenia krabbei*, p. 36.  
 Large hooks 170 to 220  $\mu$  long. Genital papilla small and not prominent. Vagina forms a sort of crescent by dilation and curvature near lateral margin of segment. Gravid segments with a median longitudinal groove terminating in a notch posteriorly-----*Taenia hydatigena*, p. 28.

In the above key the distinction between *Taenia taeniaformis* and *Taenia laticollis* is not well drawn. As a matter of fact, it appears impossible to draw any adequate distinction. All the described specimens of *T. laticollis* appear to have been based on immature specimens, and the descriptions of the genitalia with their topography, so essential in present-day specific concepts, have never been published. It is an open question in the writer's mind whether there

is a distinct species, *T. laticollis*, or whether *T. laticollis* is a synonym of *T. taeniaeformis*. So far as the descriptions are concerned, and in view of the host records from Felidae, including the lynx, there is, if anything, more likelihood that it is a synonym.

TAENIA LATICOLLIS Rudolphi, 1819a.

*Specific diagnosis.*—*Taenia*: Head spherical to club-shaped, about 1 to 1.22 mm. in diameter. Rostellum cylindrical to conical, and 600 to 700  $\mu$  in diameter, sharply circumscribed at its base. A crown of 38 to 60 hooks, the large hooks (?) 380 to 420  $\mu$  long and with a blade only slightly curved, the handle slightly wavy, and the guard rounded conical in outline with a slight bulge on the side toward the blade. The small hooks (fig. 1) are 150 (?) to 183  $\mu$  long with a blade even less curved than that of the large hook, the handle thick and stumpy, rounded oblong in shape, and only slightly longer than the thick, rounded conical guard. The suckers have a diameter of 340 to 400  $\mu$  and are quite prominent. There is no neck, body segmentation beginning immediately back of the head and with no diminution in diameter. The first segments are short, later becoming square and finally oblong and longer than broad with a maximum diameter of 2 mm. The length of strobilae observed is 50 to 95 mm. Genital pores irregularly alternate and prominent.



FIG. 1.—TAENIA LATICOLLIS. SMALL HOOK.  $\times 150$ . AFTER LÜHE, 1910.

*Male genitalia.*—Not described.

*Female genitalia.*—Not described.

*Hosts.*—*Lynx lynx* (*Felis lynx*), *Lynx canadensis*.

*Location.*—Intestine.

*Localities.*—Europe, (?) United States.

*Life history.*—Unknown.

The above description has been compiled from Rudolphi (1819a), Diesing (1850a), Leuckart (1856a), and Lühe (1910, p. 697). Diesing repeats Rudolphi's description, Leuckart had some new material, while Lühe has reexamined Rudolphi's types, without, however, adding more than a few details to our knowledge. Lühe thinks that *Taenia novella* Neumann, 1896f, is probably identical with *T. laticollis*, but the presence of a distinct neck in *T. novella* and the shape, size, and number of hooks are all features that relate it to *T. pisiiformis*, as Neumann noted in describing his new species. Leuckart states that the hook sizes are almost exactly those of *T. taeniaeformis*, and the figures in the specific diagnosis are made on the basis of this statement. None of the described material has been fully developed, so the important genital structures are unknown.



Stiles and Hassall (1894*d*) record this parasite from *Lynx canadensis* and note the presence of the specimens in the Army Medical Museum, but they give no further data as to where it was collected or by whom determined, probably because there was no record of these facts. It would require a very careful examination before anyone would be safe in saying that a tapeworm collected from *Lynx canadensis* on the American continent was identical with the imperfectly known *Taenia latifolia* from the European lynx, and the presence of this tapeworm in North America must be regarded as questionable.

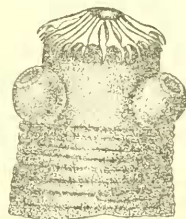


FIG. 2.—TAENIA TAENIAEFORMIS. HEAD VIEWED FROM THE SIDE.  $\times 15$ . AFTER NEUMANN IN RAILLIET, 1893*a*.

TAENIA TAENIAEFORMIS (Batsch, 1786) Wolffhügel, 1911.

*Synonyms*.—*Vermis vesicularis muris* Hartmann, 1695*b*; *Fasciola muris hepaticae* Roederer, 1762*a*; *Taenia hydatigena* Pallas, 1766, part; *Vermis vesicularis teniaeformis* Bloch, 1780*a*; *Taenia collo brevisimo* Bloch, 1782*a*; *Taenia serrata* Goeze, 1782*a*; *Hydatigena taeniaeformis* Batsch, 1786; *Cysticercus fasciolaris* Rudolphi, 1808*a*; *Taenia crassifolia* Rudolphi, 1810*a*; *Taenia teniaeformis* (Bloch, 1780*a*)

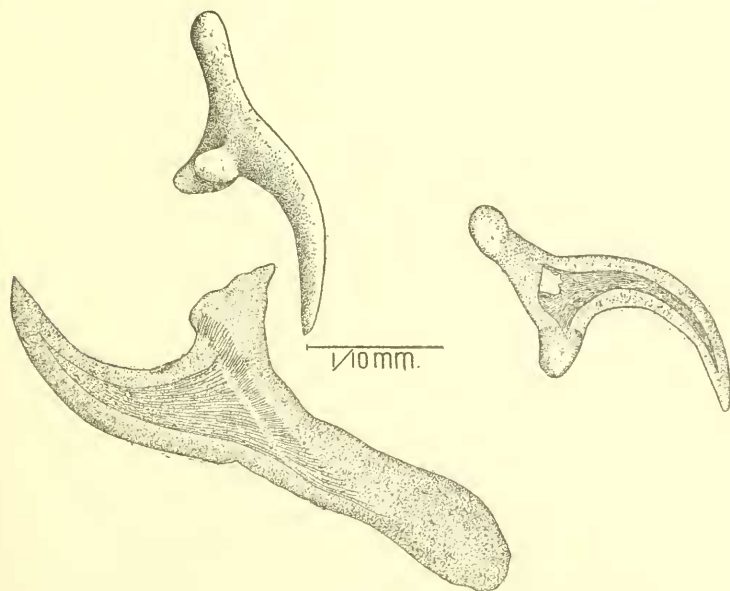


FIG. 3.—TAENIA TAENIAEFORMIS. LARGE AND SMALL HOOKS.

Stiles and Stevenson, 1905*a*. (For additional synonyms see Stiles and Stevenson, 1905*a*.)

*Specific diagnosis*.—*Taenia*: Head thick, cylindrical anteriorly (fig. 2), and 1.7 mm. thick. The rostellum is short and armed with a double crown of 26 to 52 hooks. The large hooks (fig. 3) are 360

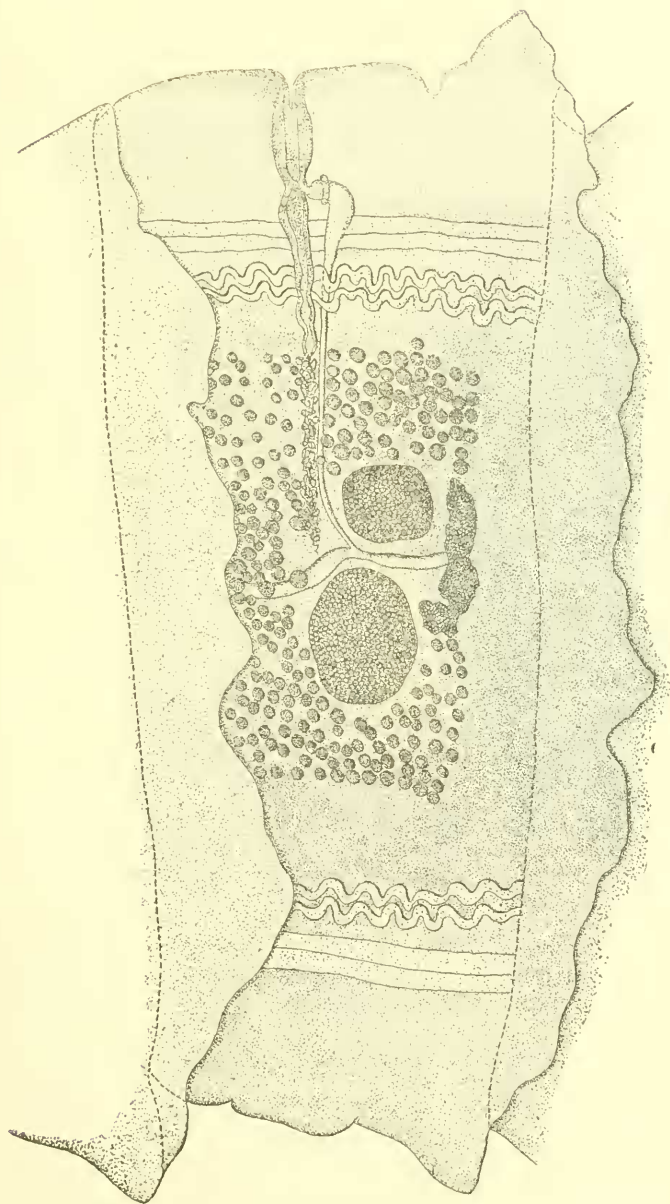
to 420  $\mu$  long. They have a blade of rather slight curvature; a handle which maintains a generally straight direction except at its distal extremity where it curves dorsad, and with a dorsal swelling near its middle and another smaller dorsal swelling at its union with the blade; and a guard with a tendency to bifid structure and presenting in lateral view parallel borders proximally and a conical termination distally. The small hooks (fig. 3) are 250 to 270  $\mu$  long. They have a blade of moderate curvature; the handle is straight with a slight enlargement distally, the enlargement curved dorsad; the guard enlarges just beyond its point of attachment, forming a neck between the enlargement and the attachment, and then terminates in a conical distal structure. The suckers are very prominent, being set on the cylindrical head at an angle pointing forward and outward. There is no neck, segmentation beginning directly posterior of the suckers and the initial segments being as broad as or broader than the head. The strobila attains a length of 15 to 60 cm. and a maximum width of 5 to 6 mm. The anterior segments are very short, the following are cuneiform, and the terminal are elongate, 8 to 10 mm. long by 5 to 6 mm. wide. Mature segments are wider than long and only terminal gravid segments are longer than wide. Calcareous corpuscles are numerous and oval. The parenchyma at times shows numerous rather large areas that fail to stain with carmine. The genital papilla is in the middle of the lateral margin,



FIG. 4.—*TAENIA TAENIAEFORMIS*. DIAGRAM SHOWING THE TRANSVERSE EXCRETORY CANAL ENCIRCLING EACH DORSAL CANAL. AFTER LOVELAND, 1894.

or anterior of the middle, is flat and inconspicuous, and is elongated along the longitudinal axis of the strobila. The transverse excretory canal is a single tube in the median portion of the strobila, but at its union with the ventral canal it forms two branches which pass dorsally and ventrally and surround the dorsal excretory canal (fig. 4). The dorsal excretory canal is very sinuous and thick walled.

*Male genitalia* (fig. 5).—The testes are numerous, oval or spherical in shape, and are set close together in the lateral portions of the median field close to the excretory canals. For the most part they leave a clear field in the vicinity of the median stem of the uterus, but may extend across this anteriorly; they press close to the field occupied by the genital canals, or even invade it, and lie in contact with the lateral portions of the ovaries and extend posterior of the ovaries but not quite to the vitellarium. The vas deferens is very much looped in a dense mass of closely approximated coils along the transverse and longitudinal axis of the strobila, and apparently originates at some distance from the median stem of the uterus on the pore side of the segment. The cirrus pouch is slender, frequently curved in gravid segments, and is difficult to observe in toto mounts.



Vagina

FIG. 5.—*TAENIA TAENIAEFORMIS*. MATURE SEGMENT. THE VAGINA PRESENTS THE APPEARANCE OF TERMINATING IN THE UTERUS.

In mature segments it attains a length of 430 to 475  $\mu$  and a maximum diameter around 70  $\mu$ ; in gravid segments the cirrus pouch shortens and thickens, its length being 300 to 345  $\mu$  and its maximum diameter about 85  $\mu$ .

*Female genitalia* (fig. 5).—The ovaries are compact, circular in outline, the one on the pore side being smaller than the one on the aporal side. The vitellarium is elongated along the transverse axis of the worm, stains very densely, and is very conspicuous; it is in contact with the posterior curvature of the ovaries and extends across the posterior portion of the interovarian field; it does not extend as far laterally as do the ovaries. The shell-gland is inconspicuous and appears to be commonly obscured by either the ovaries or the vitellarium. Near its union with the genital sinus, the vagina commonly presents a curve or even a conspicuous loop toward the posterior portion of the segment, and at this point the vagina is encircled by a well-developed sphincter. From here the vagina parallels the course of the cirrus pouch and the vas deferens and then curves around the nearest ovary to the interovarian field. Even in the mature segments the median stem of the uterus begins the formation of two lateral branches, one on each side, at the anterior end of the segment. As these develop, other branches form behind them, the new branches being added posteriorly until they invade the region of the

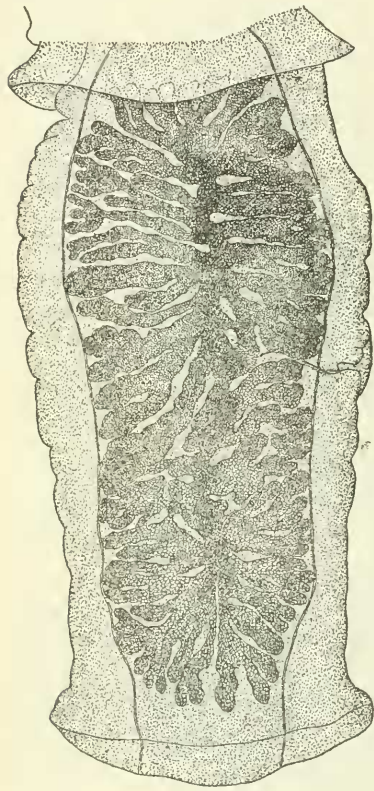


FIG. 6.—TAENIA TAENIAEFORMIS. GRAVID SEGMENT.

ovaries and obliterate them. The lateral branches are notably parallel to one another along the transverse axis of the strobila and show comparatively little tendency to subdivide, but rather a tendency to become sacculate at the distal extremities, so that the segment becomes filled with eggs, not as the result of the formation of numerous branches and the anastomosis of these branches, but as the result of the sacculation of the main lateral branches and especially of their distal extremities (fig. 6). The eggs are spherical and 31 to 37  $\mu$  in diameter.

*Hosts*.—Primary: *Felis catus* (*F. domestica*), *F. maniculata*, *F. macroura*, *F. concolor*, *F. melivora*, *F. onca*, *F. mitis*, *F. tigrina*, *F. eyra*, *F. sylvestris* (*Catus sylvestris*), *Lynx uinta* (*Lynx uenta*), *Mustala erminea* (*Putorius erminea*). Secondary: *Mus musculus*, *Epimys rattus alexandrinus* (*M. rattus alexandrinus*, *M. tectorum*), *Epimys norvegicus*, *E. rattus rattus*, *Microtus arvalis* (*Arvicola arvalis*), *A. amphibius* (*A. amphibia*), "*Lemmus terrestris*," *Ondatra zibethica* (*Fiber zibethicus*), *Talpa europaea*, *Plecotus auritus*.

*Location*.—In small intestine of primary hosts. In liver of secondary hosts.

*Localities*.—Germany, Austria, Italy, France, England, Denmark, Iceland, Persia, Japan, United States.

*Life history*.—Eggs developed by the adult worm in the intestine of the primary host pass out and are ingested by the secondary host in contaminated food or water. In the digestive tract of the secondary host, the embryo escapes from the shell and makes its way to the liver, where it develops into the larval stage or bladderworm, commonly known as *Cysticercus fasciolaris*. This bladderworm is characterized by the presence of a very small caudal bladder or vesicle filled with fluid and a very long strobilate connection between this caudal bladder and the head. When the cysticercus is ingested by the primary host, the caudal bladder digests off and new segments are formed back of the existing strobilate portion, thereby developing into the strobilate tapeworm.

The record from *Lynx uinta* in the above list is new. It should be noted that Lühe (1910) states that an examination of Diesing's South American cestodes, on which some of Diesing's records of *T. taeniaeformis* are based, did not disclose a single specimen of this worm.

TAENIA MACROCYSTIS (Diesing, 1850a) Lühe, 1910.

*Synonym*.—*Cysticercus macrocystis* Diesing, 1850a.

*Specific diagnosis*.—*Taenia*: Head 1.25 to 1.6 mm. in diameter. Rostellum from 515 to 690  $\mu$  in diameter and armed with a double crown of 60 to 74 hooks (fig. 7). The large hooks are alternated with the small in the customary manner, but in addition every other large hook is set a little closer to the center of the hook circling than is the case with the remaining large hooks, with the result that the hook crown is arranged in one circling of small hooks and two circlets

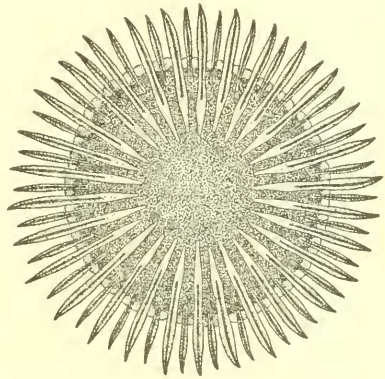


FIG. 7.—TAENIA MACROCYSTIS. HOOK CIRCLING VIEWED FROM THE FRONT.  $\times 60$ . AFTER LÜHE, 1910.

of large hooks. This alternating arrangement of the large hooks is also observed in a lateral view of the head (fig. 8). The large hooks are 320 to 365  $\mu$  long. When the head is viewed from the front, showing the dorsal edge of the hooks, the large hooks are an elongate spindle shape, with a slight constriction along the middle portion. The blade and the handle attain their maximum thickness of 27  $\mu$  at their middle points, diminishing to 20  $\mu$  near the guard. From the lateral view (fig. 9) the large hooks present a blade with a moderate curve; a handle which is very variable in outline; it may



FIG. 8.—*TAENIA MACROCYSTIS*. LATERAL VIEW OF HEAD.  $\times 42$ . AFTER LÜHE, 1910.

be continuous dorsally with the straight line of the blade, and be almost straight, with a very slight undulation and a small enlargement at the end, this end tending to bend slightly in the ventral direction, or it may narrow to a rather acute tip and have a smooth or knobbed outline; and a guard that is somewhat triangular in outline or in some cases with the proximal portion presenting almost parallel sides and terminating distally in a triangular portion. The small hooks are 180 to 200  $\mu$  long. From the lateral view they present a blade of moderate curve; a thick, short handle curving dorsally; and a thick irregularly triangular guard. The suckers are not prominent and are 290 to 350  $\mu$  in diameter. The neck is somewhat smaller than the head and is 600  $\mu$  to 1.3 mm. long, measuring from the posterior margin of the suckers to the first trace of segmentation. The strobila

(fig. 10) attains a length of 12 cm., a maximum width of 2 mm., and is composed of 90 to 100 segments. The genital pore lies near the middle of the segment and is very prominent. The dorsal excretory canal lies lateral of the plane of the ventral canal. The ventral canal is in the ventral portion of the segment and not merely ventral of the dorsal canal. The transverse canal connects the two ventral canals in the usual way. Youngest segments about 750  $\mu$  wide. About the eighth segment, the maximum width occurs, segments being 2.2 mm. wide and 2.5 mm. long. The largest segments are 7 mm. long and 1.5 mm. wide. The genital primordia are visible about 1.5 mm. back of the head in the median portion of about the twentieth segment. The cirrus pouch and vagina lie between the dorsal and ventral excretory vessel and the longitudinal nerve is ventral of the cirrus pouch and vagina. The calcareous corpuscles are 19 by 13  $\mu$  in diameter.

*Male genitalia.*—The testes are comparatively few in number and are oval, the long axis paralleling the transverse axis of the strobila;

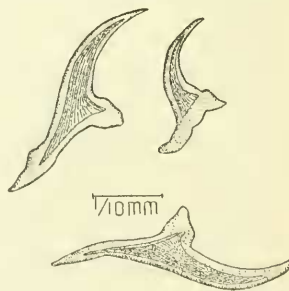


FIG. 9.—*TAENIA MACROCYSTIS*. LARGE AND SMALL HOOKS.

they lie in the lateral portion of the median field and cross the median field anteriorly; they appear to cross the field of the vas deferens and vagina at times, and extend close to the ovaries laterally as a rule, occasionally occurring posterior of the lateral portion of the ovaries; they do not lie so near the dorsal transverse musculature as in *Taenia taeniaeformis*. The vas deferens is very much looped, but pursues a fairly straight course from a point near the median stem of the uterus, on the pore side of the segment to the cirrus pouch. The cirrus pouch is very long and narrow and extends from the median border of the ventral excretory canal across both canals; it is 300 to 345  $\mu$  long and 35 to 60  $\mu$  wide.

*Female genitalia.*—The ovaries are elongated along the transverse axis of the strobila and inclose, usually, an oval to round interovarian field; the individual branches of the ovary are only moderately compact; the ovaries are of the same size, or the one on the aporal side may be slightly larger. The vitellarium is elongated along the transverse axis of the worm in contact with the posterior curvature of the ovaries and extends about as far laterally as do the ovaries. The shell-gland is obscured or inconspicuous. The vagina comes in from the genital pore in a long straight line and makes a very slight curve around and close to the nearest ovary. The uterine stem begins its initial development in the posterior portion of the segment, widening to fill the interovarian field and sending branches posterior of the ovaries. In the gravid segments (fig. 11) there are on each side 8 to 15 lateral branches, relatively short and themselves branching. In the last segments the main branches are amalgamated at the base. The egg is oval, 34 to 38  $\mu$  by 25 to 27  $\mu$  in diameter, with a shell 4.5  $\mu$  thick.

*Hosts.*—Primary: *Felis tigrina*, *F. yagouaroundi* (*F. jaguarundi*), *F. sp.*, *Galictis sp.*, *Lynx rufus* (*L. rufa*), *L. baileyi*. Secondary: *Sylvilagus brasiliensis* (*Lepus brasiliensis*).

*Location.*—Intestine of primary host: Free in body cavity or encapsuled in the liver, in the region of the kidney or between the back muscles



FIG. 10.—TAENIA  
MACROCYSTIS.  
ENTIRE STRO-  
BILA.



FIG. 11.—TAENIA  
MACROCYSTIS.  
GRAVID SEG-  
MENT.  $\times 5.5$ .  
AFTER LÜHE,  
1910.

in the secondary host.

*Localities.*—Brazil, Paraguay, United States (North Carolina; Boulder, Colorado).

*Life history.*—The eggs produced by the strobilate tapeworm in the intestine of the primary host pass out and are ingested on food or in water by the secondary host where they develop to form the intermediate larval stage or bladderworm, known as *Cysticercus macrocystis* and very similar to *Cysticercus fasciolaris*. On ingestion of this bladderworm by the primary host in preying on the secondary host, the terminal vesicle digests off while the head and its strobilate connection with the bladder develops attached segments and so forms the strobilate worm.



FIG. 12.—*TAENIA BALANICEPS*. HEAD. AFTER HALL, 1910.

The material recorded here from the United States is in the collection of the United States Bureau of Animal Industry.

That from *Lynx ruffus* was collected by Doctors Hassall and Graybill from a lynx sent from North Carolina to the National Zoological Park at Washington, District of Columbia, and that from *L. baileyi* was collected at Boulder, Colorado, by Dr. Max Ellis.

**TAENIA BALANICEPS** Hall, 1910.

*Specific diagnosis.*—*Taenia*: Head acorn-shaped (fig. 12), 735  $\mu$  long by 534 to 753  $\mu$  wide. Rostellum rounded and prominent, 307  $\mu$  in diameter, and armed with a double crown of 28 to 32 hooks, of which the larger are easily lost. The hooks are set far forward of the suckers. The large hooks (fig. 13) are

145  $\mu$  long. They have a blade of moderate curvature; the handle tapers toward its distal extremity; the distal extremity, which is not enlarged, curves slightly dorsad, and in lateral view the ventral outline is slightly convex, while the dorsal outline presents a slight median swelling and another slight swelling at the union of the blade

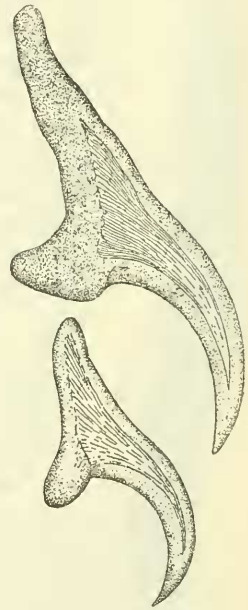


FIG. 13.—*TAENIA BALANICEPS*. LARGE AND SMALL HOOKS. AFTER HALL, 1910.



and handle; the guard is roughly conical with a protrusion toward the blade at the point of union with the blade. The small hooks

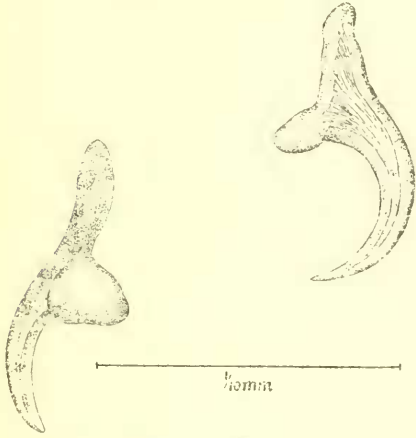


FIG. 14.—*TAENIA BALANICEPS*. SMALL HOOKS. AFTER HALL, 1910.

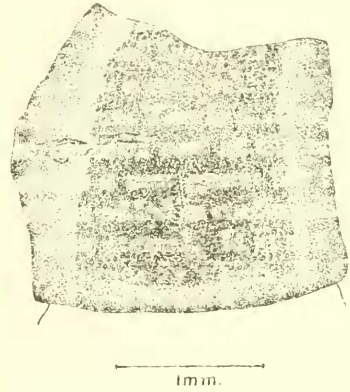


FIG. 15.—*TAENIA BALANICEPS*. MATURE SEGMENT. AFTER HALL, 1910.

(figs. 13 and 14) are 93 to 98  $\mu$  long. They have a strongly curved blade; the handle is short and thick and may be straight or present a slight curvature dorsad at its distal extremity; the guard is rather oval in lateral outline. The suckers are round, the bulb of the sucker being 215 to 265  $\mu$  in diameter. The neck is distinct and rather long, the maximum length being about 1.2 mm. from the posterior margin of the suckers to the first distinct segmentation. The strobila may attain a length of over 24 cm. Mature segments (fig. 15) are approximately square in outline and are about 2 mm. long by 2 to 2.5 mm. wide. Gravid segments (fig. 16) are 5.5 to 10.5 mm. long and 2 to 4 mm. wide. The genital canals pass out to the genital pore between the dorsal and ventral longitudinal excretory vessels and either dorsal or ventral of the main nerve trunk. The transverse excretory canal is very large and tends to lie between two adjacent segments rather than along the posterior border of the segments. The pri-

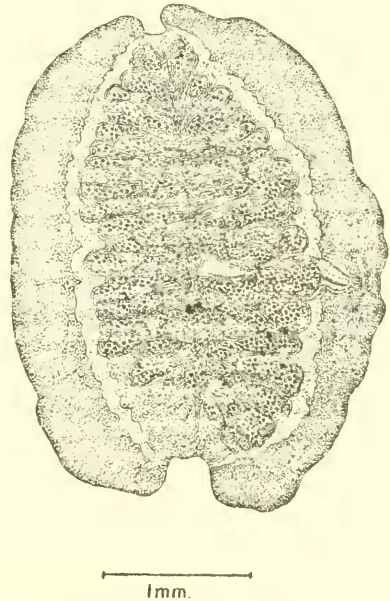


FIG. 16.—*TAENIA BALANICEPS*. GRAVID SEGMENT. AFTER HALL, 1910.

mordia of the genital organs appear a short distance back of the head; the testes, genital canals, shell-gland, and the main trunk of the uterus are clearly defined before the ovaries and yolk-gland can be detected. The genital pores are irregularly alternate and are especially prominent in segments full of developing eggs, where they may have an antero-posterior diameter of 480  $\mu$ , or about one-third the segment length. Calcareous corpuscles abundant, of variable size and shape, and with a maximum diameter of 20  $\mu$ .

*Male genitalia.*—The testes are commonly oval, with long axis paralleling that of the strobila (fig. 15), and are principally confined to two bands along the median side of the longitudinal excretory canals. A narrow band of testes crosses the extreme anterior margin of the segment, connecting the two lateral fields and leaving a large space clear of testes, frequently approximately square in outline, between this band, the lateral testicular fields, and the ovaries. The lateral testicular fields extend to the lateral margin of the ovaries, frequently encroaching on the field of the vas deferens and vagina, and are prolonged posterior of the ovaries to the yolk-gland. The vas deferens arises near the plane of the median stem of the uterus, either on the pore side or the aporal side. At the plane of the ventral excretory canal, or just lateral of this, the vas deferens opens into a tubular cirrus pouch 300 to 370  $\mu$  long, with an average length of 355  $\mu$ . The diameter of the cirrus pouch varies considerably, the maximum diameter being about 110  $\mu$ . There is no vesicula seminalis present. The length of the cirrus varies from 418 to 518  $\mu$ , with a maximum diameter of about 33  $\mu$  and a lumen diameter of about 8  $\mu$ .

*Female genitalia.*—The ovaries are elliptical to crescentic in outline with their longitudinal axes paralleling that of the strobila, and inclose an oval to oblong interovarian fields. The vitellarium is elongated in the transverse axis of the strobila and extends a slight distance between the ovaries but not lateral of them. The shell-gland is very close to the vitellarium. The vagina swings in a wide curve from the genital pore around the nearest ovary and opens into a small receptaculum seminis in the neighborhood of the shell-gland. The uterus originates as a median stem, and develops branches of unusual form. These branches are club-shaped and so closely approximated and at times so united that the ultimate result resembles a lobed sac (fig. 16). In many cases one uterine lobe extends over the longitudinal excretory canals in the vicinity of the genital pore. The eggs are ovoid in shape, are 29 to 37  $\mu$  by 27 to 33  $\mu$  in diameter, the average being 35 to 31  $\mu$ . The shell is about 4  $\mu$  thick.

*Hosts.*—Primary: *Canis familiaris*, *Lynx ruffus maniculatus* (*Lynx rufus maculatus*). Secondary: Unknown.

*Location.*—Intestine of primary host.

*Localities.*—Nevada (Fallon); Southern New Mexico.

*Life history.*—Unknown.

The uterine structure is of the type found in such tapeworms as *T. taeniaeformis* and indicates that the lynx is probably the normal

host, as the dog is certainly an accidental or occasional host. On the other hand, the narrow neck in *T. balaniceps* is quite different from the thick neck or the absence of a neck in many tapeworms parasitic in the Felidae.

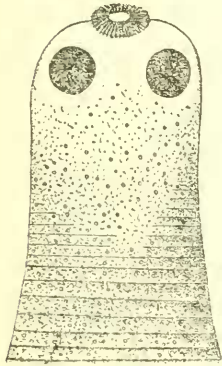


FIG. 17.—TAENIA BRAUNI. ANTERIOR EXTREMITY. X 20. AFTER SETTI, 1897.

TAENIA BRAUNI Setti, 1897b.

*Specific diagnosis.*—*Taenia*:

The head (fig. 17) is slightly flattened in the dorso-ventral plane and attains a maximum diameter of a little over 1 mm. The rostellum is not strongly developed and bears a double crown

of 30 hooks. The large hooks (fig. 18) are usually 130 to 140  $\mu$  long, occasionally only 95 to 100  $\mu$  long. The blade is of slight curvature; the handle is straight, of slightly wavy outline, and distinctly marked off dorsally at its union with the blade; the guard is conical in lateral view and tends to be bifid to a slight extent. The small hooks (fig. 19) are usually 85 to 90  $\mu$  long, occasionally only 70 to 75  $\mu$  long. The blade is of moderate curvature; the handle is short and curved, the convexity of the curve being on the ventral side; and the guard is shaped like that of the large hook. The suckers are round and are comparatively small, with a maximum diameter of 300  $\mu$ . The neck is of about the same diameter as the head and is short, segmentation being clearly marked 2 mm. from the anterior extremity of the body.



FIG. 18.—TAENIA BRAUNI. LARGE HOOKS. X 100. AFTER SETTI, 1897.



FIG. 19.—TAENIA BRAUNI. SMALL HOOKS. X 100. AFTER SETTI, 1897.



FIG. 20.—TAENIA BRAUNI. MEDIAN PORTION OF STROBILA. ACTUAL SIZE. AFTER SETTI, 1897.

The strobila attains a maximum length of 15 to 18 cm. and a maximum width of 6 mm. The anterior segments are 100  $\mu$  long and 1.3 mm. wide. In the middle of the strobila (fig. 20) the segments are still



FIG. 21.—TAENIA BRAUNI. POSTERIOR PORTION OF STROBILA. ACTUAL SIZE. AFTER SETTI, 1897.

transversely elongated, being 1.5 mm. long and 6 mm. wide. The terminal gravid segments (fig. 21) are 5 to 6 mm. long and 3.5 mm. wide. The segments are rectangular and do not present a serrate

edge on the margin of the strobila. The segments are dense owing to their thickness and the abundance of calcareous corpuscles. The genital papillae are in the middle of the segments and are prominent. The longitudinal excretory vessels are sinuous and are 500 to 700  $\mu$  from the margin of the strobila on each side.

*Male genitalia.*—The cirrus pouch is short (fig. 22), extending about half the distance from the lateral margin of the segment to the longitudinal canals and so perhaps (?) 250 to 350  $\mu$  long. It opens anterior of the vagina.

*Female genitalia.*—The vagina extends in a straight line from the genital pore toward the median line. The lateral branches of the uterus are small, numerous, and perpendicular to the median stem. They do not extend across the longitudinal excretory canals. The eggs are round and 35 to 38  $\mu$  in diameter.

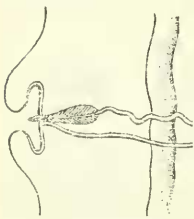


FIG. 22.—*TAENIA BRAUNI*. REGION OF GENITAL PORE. DIAGRAMMATIC. AFTER SETTI, 1897.

*Host.*—Primary: *Canis familiaris*. Secondary: Unknown.

*Location.*—In intestine of primary host.

*Locality.*—Eritrea.

*Life history.*—Unknown.

Setti states that this species does not present a true rostellum, but does bear the customary double crown of hooks. The rostellum is the distinct muscular bulb which provides the musculature for the movement of the hooks and of the apical sucker when this is present. Inasmuch as the efficiency of the hooks depends on their musculature, it seems inconceivable that a tapeworm should have a well-developed and functional crown of hooks and not have a rostellum. I have therefore modified Setti's statement, which seems to be based on a misunderstanding or misstatement of some sort, substituting the statement that the rostellum is not strongly developed. Other features of the description have been taken from Setti's illustrations, including the shape of the hooks and the apparent length of the cirrus pouch.

It is likely that this tapeworm, like *Taenia balaniceps*, is only accidentally parasitic in the dog, and that its usual host is some wild carnivore. Dogs are such common subjects of investigation for parasites the world over that while it is possible to overlook a dog tapeworm, as happened in the case of *Taenia ovis*, it is nevertheless unlikely that *T. brauni* is a customary parasite that has been overlooked.

Railliet and Henry (1915) state that the hooks in this tapeworm resemble those of the genus *Multiceps*. This is true, but the structure of the vagina differs from that which I have found in known species of the genus *Multiceps*, in that it does not present a reflexed loop near the longitudinal canals.

## TAENIA BRACHYSOMA Setti, 1899c.

*Specific diagnosis.*—*Taenia*: Head (fig. 23) about 700  $\mu$  in diameter and more or less elongate piriform in shape. Rostellum prominent



FIG. 23.—TAENIA BRACHYSOMA. ANTERIOR EXTREMITY.  $\times 20$ . AFTER SETTI, 1899.

and bearing a double crown of 30 to 32 hooks. The large hooks (fig. 24) are 135 to 145  $\mu$  long. The blade has a rather slight curvature; the handle is slightly curved, at times irregularly so, with the convexity of the curve on the dorsal surface and meeting the similar curve of the blade in a distinct obtuse angle opposite the middle of the guard; the guard is thick, and in lateral view the sides of the guard are approximately parallel, the distal extremity being bluntly rounded. The small hooks (fig. 25) are 95 to 105  $\mu$  long. The blade makes a very sharp curve toward the axis of the handle and guard and then straightens out, its distal portion being roughly parallel to the axis of the

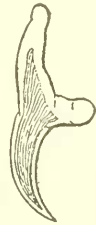


FIG. 24.—TAENIA BRACHYSOMA. LARGE HOOK.  $\times 200$ . AFTER SETTI, 1899.

handle and guard; the handle is very short and blunt, with a slight tendency to curve dorsally at the tip; the guard is rather broad, furrowed to show a trace of bifidity, and tends to be twisted so that the lateral axis lies in the plane of the blade and handle. The suckers are round and have a maximum diameter of 250 to 270  $\mu$



FIG. 25.—TAENIA BRACHYSOMA. SMALL HOOKS.  $\times 200$ . AFTER SETTI, 1899.

with a circular or elliptical aperture of about 150  $\mu$ . The neck is distinct, narrower than the head, with an average measurement of 300 to 400  $\mu$  and not exceeding 1 mm. long to the first distinct segmentation. The strobila (fig. 26) attains a maximum length of 10 cm. and a maximum width of 3 mm. The first segments are 40 to 70  $\mu$  long and 350 to 450  $\mu$  wide; 5 mm. back of the head they are 200

to 230  $\mu$  long and 600 to 900  $\mu$  wide; 1 cm. back of the head they are 240 to 260  $\mu$  long and 800  $\mu$  to 1 mm. wide; in the middle of the strobila they are 750  $\mu$  to 1.25 mm. long and 2.3 to 2.8 mm. wide; 2 cm. from the posterior extremity they are 1.25 to 1.7 mm. long and 2.5 to 3 mm. wide; the terminal segments are 2.5 to 3 mm. long and 2.5 to 2.5 mm. wide. There are 140 to 180 segments. The first segments are trapezoidal with projecting posterior angles forming a serrate strobila margin. The segments

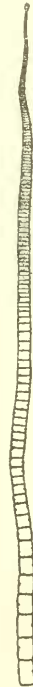


FIG. 26.—TAENIA BRACHYSOMA. ENTIRE STROBILA. ACTUAL SIZE. AFTER SETTI, 1899.

in the middle of the strobila are rectangular, almost as long as wide, and with the posterior angles less prominent and the strobila margin smoother than anteriorly. The posterior segments are almost quadrate, the last two or three longer than wide. Occasionally the middle segments are campanulate and a little longer than wide. Calcareous corpuscles are especially abundant in the anterior portion of the strobila. The small genital papilla is near the middle of segment. It is most distinct in segments in the middle of the strobila. The longitudinal excretory canals are about 500  $\mu$  from the lateral margin of the segments.

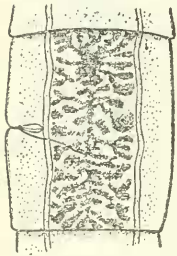


FIG. 27.—*TAENIA BRACHYSOMA*. GRAVID SEGMENT. ENLARGED. AFTER SETTI, 1899.

*Male genitalia*.—The aperture of the cirrus pouch is at the base of a genital sinus 100 to 170  $\mu$  long. The median extremity of the cirrus pouch is about at the plane of the longitudinal excretory vessels.

*Female genitalia*.—The uterus (fig. 27) occupies the median portion of the segments included between the longitudinal excretory canals. The median stem has 10 to 12 lateral branches on each side, approximately perpendicular to the median stem, and terminating distally in a variable number of smaller branches of various sizes, shapes, and positions.

Developed embryophores are only found in the last four or five segments. The eggs are spherical and 32  $\mu$  in diameter.

*Host*.—Primary: *Canis familiaris*. Secondary: Unknown.

*Location*.—In intestine of primary host.

*Locality*.—Italy (Turin).

*Life history*.—Unknown.

In a general way the circumstances indicate that this tapeworm, like *Taenia brauni*, is also an accidental parasite of the dog.

Setti's statement that the guard of the small hook is twisted so that the lateral axis tends to lie in the plane of the blade and handle, has been noted by Ransom (1913) with the following comment: "Setti does not make it clear whether this twisted condition is invariably present. The small hooks of *Taenia hydatigena* commonly present a similar appearance after subjection to the pressure of a cover glass." This point is well taken. Tapeworm hooks are flexible structures, capable of considerable distortion under pressure or torsion, up to the limit of flexibility, at which point, of course, breaking occurs.

#### *TAENIA PISIFORMIS* (Bloch, 1780a) Gmelin, 1790a.

*Synonyms*.—*Vermis vesicularis pisiformis* Bloch, 1780a; *Hydatigena pisiformis* (Bloch, 1780a) Goeze, 1782a; *Hydatigena utricularis* Goeze, 1782a; *Hydatigena cordata* Batsch, 1786a; *Hydatigena utricularis* Batsch, 1786a; *Vesicaria pisiformis* (Bloch, 1780a)

Schrank, 1788a; *Taenia serrata canis domestici et vulpis* Rudolphi, 1793a; *Cysticercus pisiformis* (Bloch, 1780a) Zeder, 1803a; "*Taenia serrata* Goeze" of most authors; *Taenia novella* Neumann, 1896f. (For additional synonymy see Stiles and Stevenson, 1905a.)

*Specific diagnosis.*—*Taenia*: Head (fig. 28) 1.3 mm. in diameter. Rostellum large and powerful, 515 to 640  $\mu$  in diameter, and armed

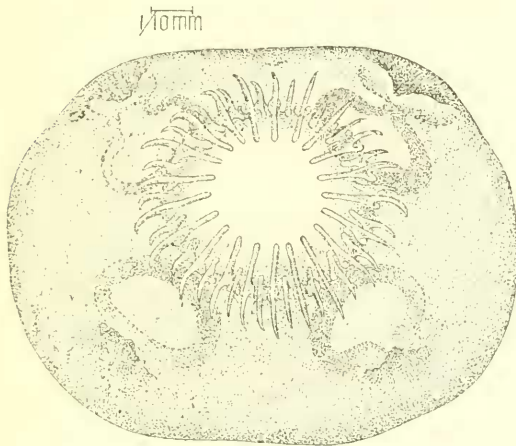


FIG. 28.—*TAENIA PISIFORMIS*. HEAD, VIEWED FROM THE FRONT.

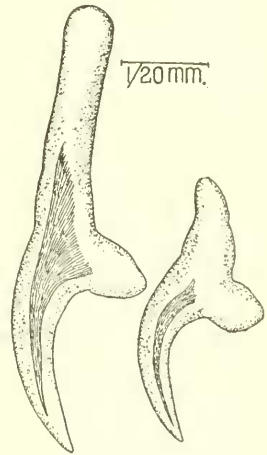


FIG. 29.—*TAENIA PISIFORMIS*. LARGE AND SMALL HOOKS.]

with a double crown of 34 to 48 strong hooks. The large hooks (fig. 29) are 225 to 294  $\mu$  long. They have a strongly curved blade; the handle is very long and, observed from the side, usually has straight sides, gradually diverging distally to a blunt rounded termination, a truly club-shaped handle, which passes dorsally rather directly into the blade save for a short elevation dorsally, which is usually present at the union of the blade and handle; the guard is rather long, thickest in its median portion, thinning slightly at its union with the blade and handle, and terminating distally in a bluntly rounded cone. The handle and guard form a very obtuse angle. The small hooks (fig. 29) are 132 to 177  $\mu$  long. They have a strongly curved blade; the handle, viewed from the side, is thick and rather short, its sides distinctly or slightly curved and approximately parallel, the convexity of the curve being ventral, and terminating as a rule, in a bluntly rounded end distally; the guard is usually distinctly and often strongly bifid (fig. 30), the depth of the cleft varying, rather oval in

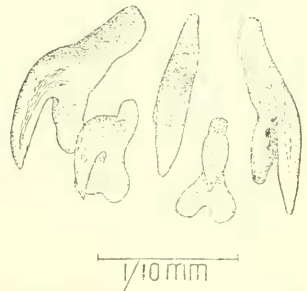


FIG. 30.—*TAENIA PISIFORMIS*. LARGE AND SMALL HOOKS AS SEEN IN A LATERAL VIEW OF THE HEAD.

outline when viewed from the side, and with a proximal protuberance toward the side of the blade. The lines of the handle and guard do not meet but are separated by a rather long interval, slightly to strongly convex in outline when viewed from the side. The distances from the distal extremity of the guard to the distal extremities of the blade and handle are very nearly equal. Viewed from the front the head (fig. 28) is approximately square with the suckers located at the corners and separated by relatively wide intervals from one another. The suckers are round to elliptical with a maximum diameter of 310 to 330  $\mu$ . The neck is but slightly narrower than the head and is 680  $\mu$  to 1.7 mm. long from the posterior margin of the suckers to the first distinct segmentation. The strobila attains a length of 60 cm. to 2 meters, average specimens being 90 to 100 cm. long and consisting of about 400 segments. The maximum width is about 4.8 mm. The first segments are very short and much wider than long. There are something less than 175 of these preceding the mature segments. The segments become mature and quadratic in shape about the hundred and seventy-fifth. There are about 25 of these mature quadratic segments. They are about 4.9 mm. long and 4.2 mm. wide at the anterior margin, 4.7 mm. wide at the posterior margin, and 4.8 mm. wide at the genital pore. Complete maturity is attained in about the two-hundredth segment, 25 cm. behind the head, and posterior of this the segments transform into gravid segments. There are 30 to 40 gravid terminal segments, making up almost half of the entire strobila, these segments attaining a length of 1 cm. and a width of 4 mm. The posterior angles of all segments are prominent, giving a characteristic serrate appearance to the strobila. The calcareous corpuscles are variable in shape and have a maximum diameter of 18  $\mu$ . The longitudinal excretory canals are about 640  $\mu$  from the lateral margin of the segment and 770  $\mu$  from the genital pore. The transverse excretory canal has the customary position in the posterior portion of the segment and connects with the ventral canal. The genital pores are irregularly alternate, commonly two in succession on one side and rarely as many as four to six in succession. The genital papilla is only moderately prominent and is located near the middle of the segment except in gravid segments where it frequently is distinctly posterior of the middle. The genital primordia are visible in toto mounts in the fifth to the twelfth segments back of the head.

*Male genitalia.*—The testes (fig. 31) are round or slightly elongated in outline and are 132 by 96  $\mu$  in diameter. There are about 400 to 500 in a segment, and they occupy nearly all the field included between the longitudinal excretory canals not actually occupied by other genital structures. In the posterior portion of the segment they fill the lateral fields clear up to the median stem of the uterus, leaving only little more than the width of the uterus free of testes



in the median field, except in the region near the ovary where the clear field is a little wider. On the pore side of the segment they extend back to the vas deferens, the space between the vas and the vagina being free of testes, and then extend from the vagina on this side, and from the anterior margin of the segment on the aporal side, back to the posterior margin of the segment. They press between the loose lobes of the ovary and posterior and dorsal of the vitellarium. Aside from the space occupied by the median stem of the uterus and the field of the vas deferens and vagina, the only space free of testes is that between the ovaries. The testes are arranged in two strata, a dorsal and a ventral, some overlying others in frontal views. The vasa efferentia open into a distinct vesicula seminalis, 210 by 350  $\mu$  in diameter, located on the pore side of the median stem of the uterus. From the vesicula seminalis the vas deferens extends posteriorly parallel to the median stem of the uterus for a short distance and then curves toward the pore side of the segment. The vas deferens is very large, much looped and irregular, with the thick loops lying very close to one another.

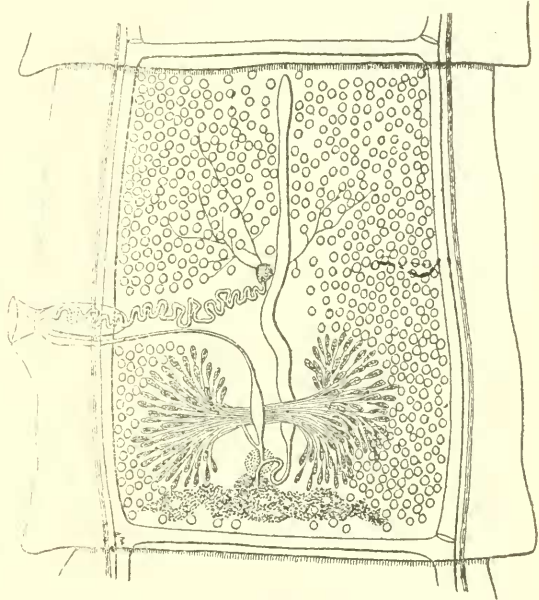


FIG. 31.—*TAENIA PISIFORMIS*. MATURE SEGMENT. ENLARGED. AFTER DEFFKE, 1891.

The cirrus pouch extends in from the margin of the segment to the plane of the ventral excretory canal, or very commonly to a point as much as 107  $\mu$  median of this plane, and is surrounded by a distinctive layer of cuboid cells. It is cylindrical or, rather, compressed elliptical in outline, with its maximum diameter in the middle. Maximum diameter, 130 to 140  $\mu$ ; length, 460 to 800  $\mu$ .

*Female genitalia.*—The ovaries (fig. 31) are somewhat reniform, the concavities of the two inclosing an oval interovarian field, and are of rather loose structure. They are very nearly equal in size. The vitellarium is very large, extending laterally past the ovaries, and forward to the posterior border of the ovaries and a short distance into the interovarian field. The shell gland is large and in frontal

view of its posterior portion appears to be embedded in or overlaid by the portion of the vitellarium which projects into the interovarian field. The vagina extends in from the genital pore almost straight or somewhat inclined anteriorly and curves around the nearest ovary, forming the receptaculum seminis in the interovarian field. In gravid segments (fig. 32) the uterine stem is very long and bears on each side 8 to 14 lateral branches, which in turn send out secondary branches, these branches usually distinct or with only a slight tendency toward terminal fusion. The eggs are elliptical, 37 by 32  $\mu$  in diameter.



FIG. 32.—*TAENIA PISIFORMIS*. GRAVID SEGMENT.

*Hosts*.—Primary: *Canis familiaris*, *C. latrans*, *C. nebracensis*, *Felis catus* (*F. domestica*), *F. tigris*, *Urocyon cinereo-argentatus*, fox. Secondary: *Oryctolagus cuniculus* (*Lepus cuniculus ferus*, *L. c. domesticus*), *L. europaeus* (*L. timidus*), *L. timidus* (*L. variabilis*), *Sylvilagus brasiliensis* (*L. brasiliensis*), *S. floridanus mallurus* (*L. sylvaticus*), *L. californicus wallawalla*, *S. floridanus mearnsii* (*L. mearnsi*), *S. palustris* (*L. palustris*), *L. americanus*, *S. auduboni baileyi*, *S. nuttalli pinetis*, *Mus musculus*, mountain beaver.

*Location*.—In intestine of primary host. In liver, mesenteries, and free or attached in abdominal cavity of secondary host.

*Locality*.—More or less cosmopolitan.

*Life history*.—Eggs produced by the strobilate tapeworm pass

out and are ingested in contaminated food or water by the primary host. The embryo is released in the digestive tract and bores its way into the liver, where it begins development as a bladderworm, commonly called *Cysticercus pisiformis*. Usually it develops to a certain point and then slips out of the liver and falls into the abdominal cavity, where it remains free for a time, ultimately becoming attached by an adventitious cyst to the mesenteries as a rule.

Of the above host records the following are new: *Lepus californicus wallawalla*, *Sylvilagus floridanus mearnsii*, *S. auduboni baileyi*,

and mountain beaver. The records from *Lepus sylvaticus* by Stiles and Hassall (1894*d*) are covered in the above list by *S. f. mallurus*. Other American records are given by Welch (1890*a*), Curtice (1892*g*), Garrison (1911), Sommer (1896), Stiles and Hassall (1898*a*), Young (1908*a*), Ward (1895*a* and 1897*b*), Leidy (1855 and 1891*a*), and Hall (1913).

*Taenia novella* Neumann, 1896*f*, has been regarded here as a synonym of *Taenia pisiformis*. It has already been noted in the discussion of *Taenia laticollis* that Lühe (1910) has regarded *T. novella* as a synonym of *T. laticollis* and the reasons given for disagreeing with this view. Neumann's specimens had a globular piriform head, 1.12 to 1.22 mm. in diameter, with four prominent suckers of slightly oval contour, 400 by 340  $\mu$  in diameter, and with a slightly prominent rostellum with a central depression and bearing 40 to 42 hooks. The large hooks (fig. 33) are 250 to 260  $\mu$  long with a thin handle of undulant contour and a little longer than the blade. The small hooks are 150 to 155  $\mu$  long with a quite long handle and a broad cordiform guard. The neck is about 3 mm. long. Substantially all of the above is in agreement with the description of *Taenia pisiformis*, and the parts that are not in exact agreement are well within the limit of variation already known. The large hooks of *T. novella* are described as having a thin handle of undulant contour. An examination of the figure given by Neumann shows a handle which I would describe as thick, showing merely the inadequacy of such relative terms. The figure is very distinctly that of the large hook of *T. pisiformis*. The undulation in outline is very slight, much less than that found by Stevenson (1904) in his study of the variation of the hooks of *T. pisiformis*. Practically the same comments apply to Neumann's statement that *Taenia novella* has a long handle. His figures show that it is relatively longer and narrower than the usual handle in *T. pisiformis*, but it is well within the limits of variation shown for these hooks by Stevenson. His statement that the neck is 3 mm. long, is probably based on unmounted material, while the measurements I have given are based on stained mounts, and hence are due to the difference between a gross measurement and a microscopic measurement.

Neumann had 23 specimens of *T. novella*, the largest specimen being 33 mm. long. This fact not only would influence the measurement of the neck, in all probability, but it suggests that the worms might have been in a host animal in which they had not come to maturity and in which they possibly never could mature. *Taenia pisiformis* is certainly not a normal parasite of the cat, but it might



FIG. 33. — TAENIA NOVELLA. LARGE AND SMALL HOOKS.  $\times 100$ . AFTER NEUMANN, 1896. REGARDED HERE AS *T. PISIFORMIS*

be an occasional parasite, developing to a certain stage at least. Dramard and Benoit-Bazille (1905) have recorded *T. pisiformis* from *Felis tigris*. [Since the above was written, Ackert and Grant (1917) have developed immature *T. pisiformis*, up to 22 mm. long, in kittens, by feeding *Cyst. pisiformis*.]

Some of the maximum measurements given in the specific diagnosis of this species are cited from Deffke (1891*a*), and in the writer's experience are much in excess of the usual maximum measurements. Stevenson (1904) has noted that some of Deffke's measurements are not substantiated by his illustrations. This is especially true of the measurements of the cirrus pouch.

In counting the testes in toto mounts, a count of 300 is apt to be obtained rather than 400 to 500, but this is probably due to the fact that the testes are in two strata and that some overlie others.

It is commonly stated that this species has 8 to 10 lateral branches on each side of the main uterine stem. In this case, as in the case of other species of tapeworms examined by the present writer, the number of lateral branches of the uterus may be larger. Stained and mounted specimens may show as many as 14 branches, exclusive of the terminal anterior and posterior digitations of the main uterine stem.

TAENIA HYDATIGENA Pallas, 1766.

*Synonyms*.—*Lumbricus hydropicus* Tyson, 1691*a*, pre-Linnaean; *Hydra hydatula* Linnaeus, 1767*a*; *Vermis vesicularis eremita* Bloch, 1780*a*; *Hydatigena orbicularis* Gocze, 1782*a*; *Taenia marginata* Batsch, 1786*a*; *Cysticercus tenuicollis* Rudolphi, 1810*a*. (For additional synonyms, see Stiles and Stevenson, 1905*a*.)

*Specific diagnosis*.—*Taenia*: Head variable in shape, reniform, spherical, cylindrical or truncated pyramidal with the square to oblong base of the pyramid constituting the rostellar face of the head, and with a head diameter of about 1 mm. Rostellum with a double crown of 26 to 44 hooks. The large hooks (fig. 34) are 170 to 220  $\mu$  long. They have a blade of moderate curvature; the handle, viewed from the side, has a rather sinuous contour, with its dorsal and ventral margins approximately parallel, and meets the blade dorsally in an obtuse angle; the guard is actually and relatively long, about 40  $\mu$ , and rather narrow, somewhat cylindrical proximally and terminating conically distally, the cylindrical portion sometimes slightly larger at its union with the conical portion, and the guard forming almost a right angle with the ventral outline of the handle. The small hooks are 110 to 160  $\mu$  long. They have a strongly curved blade; the handle, viewed from the side, is long, narrow, and curved, the convexity being on the ventral surface; the guard is long, narrow and cylindrical, viewed from the side, and is much expanded and cordiform to Y-shaped when viewed along the longitudinal axis

of the blade. The suckers are situated at the angles of the head. They are relatively large, about 310  $\mu$  in the longest diameter, and are set rather close to one another. The neck is distinct or indistinct, according to the state of contraction, and is approximately 500  $\mu$  long from the posterior margin of the suckers to the first distinct evidence of segmentation. The strobila is from 75 cm. to 5 meters long, the average strobila being 2 meters long and consisting of 650 to 700 very thick segments. In such a strobila the short wide segments at the anterior portion of the strobila gradually become larger, but the mature segments are also wider than long. Mature segments begin

about 50 cm. behind the head about the two hundred and seventy-fifth to the three hundredth segment. These segments are about half as long as wide, being 3.78 mm. long and 7.5 mm. wide. These are followed by about 50 quadratic segments in which the uterus branches are forming and the genital glands undergoing atrophy. Gravid segments begin about the five hundred and eightieth to the six hundred and tenth segment, and are longer than wide, being 10 to 15 mm. long and 4 to 5 mm. wide. The lateral margins of the strobila are smooth and without serration, but the posterior margin of each segment is continued posteriorly over the anterior portion of the succeeding segment, forming an enveloping cuff. In the gravid segments there is a tendency, characteristic of the species, to show a median longitudinal furrow on the dorsal and

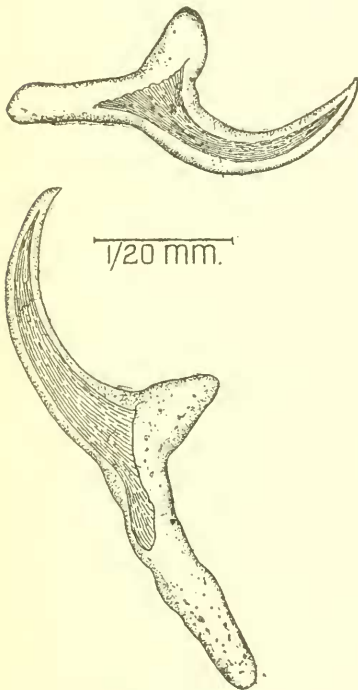


FIG. 34.—TAENIA HYDATIGENA. LARGE AND SMALL HOOKS.

ventral surfaces, the furrow terminating posteriorly in a notch. The genital papillae are near the middle of the lateral margins of the segments and are not at all prominent. The calcareous corpuscles are usually oval, with a maximum diameter of 20  $\mu$ . The longitudinal excretory canals are about 700  $\mu$  from the lateral margin of the segment.

*Male genitalia.*—There are about 600 to 700 relatively small testes (fig. 35), which are very thickly distributed in one plane and separated by a continuous sheet of parenchyma from the ovary and the vitelline gland. The testes extend close to the median stem of the uterus and the vas deferens and vagina, leaving little clear space

about these free fields, but they leave a fairly wide, distinct, clear field about the ovaries and vitellaria and do not extend posterior of these. The vas deferens is without a vesicula seminalis and arises at a little distance from the median stem of the uterus on the pore side of the segment. The vas deferens is narrow and is looped in comparatively open loops. It is quite commonly pigmented. The cirrus pouch is cylindrical, 450  $\mu$  long and 130  $\mu$  wide.

*Female genitalia.*—The ovaries are approximately circular in dorso-ventral view, except for a flattening on the sides nearest one another, by virtue of which they bound an interovarian space of rectilinear outline. The ovary on the aporal side of the segment is distinctly larger than that on the pore side. The vitellarium has a very distinct and regular reticular structure. It is narrow and pro-

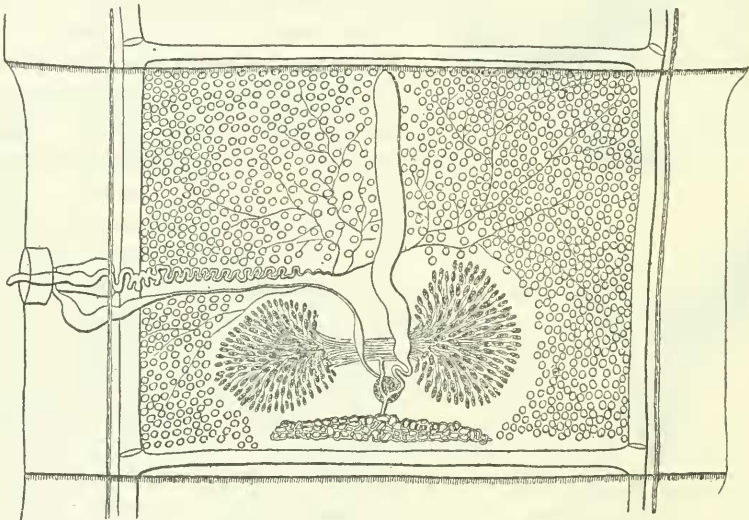


FIG. 35.—*TAENIA HYDATIGENA*. MATURE SEGMENT. ENLARGED. AFTER DEFFKE, 1891.

longed along the transverse axis of the worm and does not extend beyond the ovaries laterally or into the interovarian field anteriorly. The shell-gland is distinctly in the interovarian field and is not in apparent contact with the vitellarium. The vagina curves posteriorly from the genital cloaca and then anteriorly to the level of the excretory canals, forming a sort of crescent, which is widely dilated. From the excretory canals it extends straight in toward the median portion of the segment, paralleling practically the entire extent of the vas deferens, and then curving around the nearest ovary to the receptaculum seminis in the interovarian field. The vagina is not infrequently pigmented. In gravid segments (fig. 36) the uterine stem bears on each side few, 5 to 10, thick lateral branches, which in turn send out few thick secondary branches which remain fairly distinct

as a rule. The eggs are elliptical, 38 to 39  $\mu$  long and 34 to 35  $\mu$  wide. The shell is 4  $\mu$  thick.

*Hosts*.—Primary: *Canis familiaris*, *C. lupus*, *C. mesomelas*, saddle-backed jackal, (?) *Felis catus* (*F. domestica*). Secondary: *Bos taurus*, *Ovis aries*, *Sus scrofa*, *S. scrofa domestica*, *Capra hircus*, Duiker, Springbok, Rooi reebok, "*Simia faunus*," *Presbytis entellus* (*Semnopithecus entellus*), *Lasiopyga cynosura* (*Semnopithecus cynosurus*), *Lasiopyga mona* (*Cercopithecus mona*), *Lasiopyga sabaeus* (*C. sabaeus*), *Pithecus* species (*Macacus cynomolgus*), *Simia sylvanus* (*M. inuus*), *Papio maimon*, *Sciurus niger neglectus* (*S. cinereus*), *S. vulgaris*, *Ovis argali*, *O. musimon*, *Rupicapra rupicapra* (*R. tragus*), *Oryx beisa*, *O. leucoryx*, *Saiga tartarica*, *Gazella dorcas*, *Antidorcas euchore* (*G. euchore*), *Kobus ellipsiprymus*, *Mazama rufa* (*Cariacus rufus*), *Mazama nemorivaga* (*C. simplicicornus*), *Capreolus capreolus* (*C. caprea*), *Rangifer tarandus* (*Tarandus rangifer*), *Axis axis* (*Cervus axis*), *C. claphus*, *Rusa unicolor* (*C. unicolor*), *Phachochoerus africanus*, *P. aethiopicus*, *Potamochoerus koiropotamus* (*P. porcus*), Bharrel, *Odocoileus hemionus* (*Cariacus macrotis*), *Rangifer terrae-novae* (*R. novae-terrae*), *Alces alces* (*A. machlis*), *Ovis mexicana*, *Odocoileus americanus* (*Cervus virginianus*), Columbia deer.

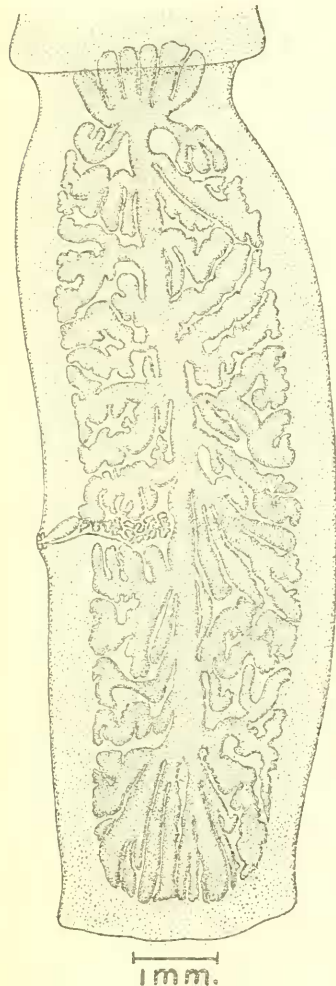


FIG. 36.—TAENIA HYDATIGENA. GRAVID SEGMENT. AFTER RANSOM, 1913.

Location.—In small intestine of primary host. Imbedded in liver, or free or attached to viscera, and especially to mesenteries, in abdominal cavity of secondary host.

*Locality*.—Cosmopolitan.

*Life history*.—The eggs produced by the adult worm in the intestine of the primary host pass out and are ingested in contaminated food or water by the secondary host. In the digestive tract of the secondary host the embryo is liberated from its shell and bores its

way into the liver, where it wanders around for a time, apparently following the course of the blood vessels and causing a condition resembling angioma. The embryos then develop in the liver to the bladderworm, called *Cysticercus tenuicollis*, and are either found adherent to the capsule of the liver, or, more commonly, they slip into the abdominal cavity and are commonly found surrounded by an adventitious cyst attached to the mesenteries or omentum. On ingestion of these bladderworms by the primary host in eating the secondary host, as would be the case under natural conditions, the head on the bladderworm attaches in the intestine and develops segments, forming the strobilate worm.

Of the hosts given above those not known to have been reported previously are the Bharrel, Columbia deer, *Odocoileus hemionus*, *Rangifer novae-terrae*, *Alces alces*, *Ovis mexicana*, and *Odocoileus americanus*.

Writers commonly state that this species has from five to eight lateral uterine branches, but I have often found 10 and believe a fair count in some cases would show more. Comment has already been made on the count of uterine branches in connection with *Taenia pisiformis*.

Stiles and Hassall (1912) note that this tapeworm has been reported for *Felis catus* (*F. domestica*). I have not found the reference in question and so am not in a position to comment on this. If it were backed up by such evidence as there is to support the idea that *Taenia novella* is really a dog tapeworm I would accept it. At present, and for the purposes of this paper, the case will have to be regarded as not proven.

The very striking median groove and its posterior notch on the gravid segments is figured by Stiles (1898), but is not mentioned by him. Deffke (1891a) apparently overlooked it and I have not found any mention of it.

#### TAENIA OVIS (Cobbold, 1869a) Ransom, 1913.

*Synonyms*.—*Cysticercus ovis* Cobbold, 1869a; *Cysticercus ovipariens* Maddox, 1873a; *Cysticercus cellulose* of Küchenmeister, 1878, in Küchenmeister and Zürn, 1878–1881a (misdetermination); *Cysticercus tenuicollis* of Chatin, in Railliet, 1885a (misdetermination); *Cysticercus oviparus* Leuckart, 1886d.

*Specific diagnosis*.—*Taenia*: The head is oblong, flattened in the dorso-ventral direction and elongated along the transverse axis, and is 800  $\mu$  to 1.25 mm. wide. The rostellum is well developed, 375 to 430  $\mu$  in diameter, and bears a double crown of 24 to 36 hooks. The large hooks (fig. 37) are 156 to 188  $\mu$  long, the average being 173  $\mu$ . The blade is of slight to moderate curvature; the handle is narrow, with its dorsal and ventral margins, viewed from the side, approxi-



mately parallel, usually quite distinctly wavy in outline but occasionally almost straight, and usually with a more or less well-marked convexity on the dorsal border near the union with the guard, the union, as a result, forming a more or less obtuse angle, while the other end of the convexity frequently terminates in a notch in the dorsal margin of the handle; the guard is at right angles to the blade and is roughly conical to elongate cordiform in lateral view, the maximum thickness being a short distance from the point of union and so forming a proximal neck. The small hooks are 96 to 128  $\mu$  long. The blade does not present a prominent concavity on its ventral surface, but it makes a sharp curve, amounting at times almost to a bend, and then straightens out with the point past the extended longitudinal axis of the handle; the handle is long, narrow, and tapering with a marked tendency, unusual in dog tapeworms, to turn ventrally at the distal extremity, and with the dorsal and ventral margins rather straight or only slightly wavy; the guard is united to the handle at an obtuse angle and is of approximately the same shape as that of the large hook, the guard at times showing a slight median ventral groove. The suckers are 270 to 320  $\mu$  in diameter and are set on at the corners of the oblong head. The neck is distinct, narrower than the head, 650 to 900  $\mu$

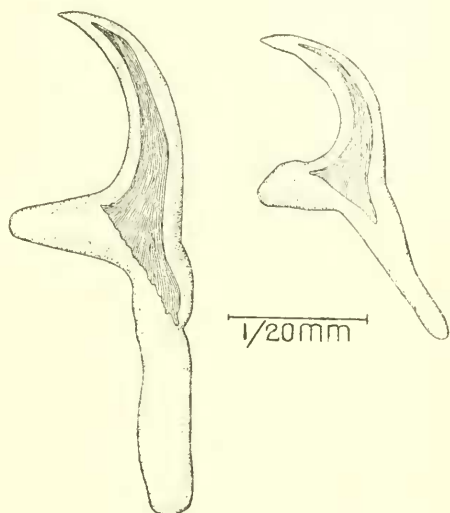


FIG. 37.—*TAENIA OVIS*. LARGE AND SMALL HOOKS.

wide, varying in length according to the state of contraction, a specimen in a state of moderate contraction having a neck about 600  $\mu$  long from the posterior border of the suckers to the first distinct segmentation. The strobila is 45 to 110 cm. long, with a maximum width of 4 to 8.5 mm., and has a tendency to twist in the form of a spiral. The segments have convex lateral borders. Immature and mature segments are wider than long; gravid segments are longer than wide. Mature segments are 1.9 to 3.5 mm. long and 5.5 to 6.5 mm. wide. Gravid segments attain a maximum length of 15 mm., the width varying with the state of contraction, from 3 to 5.5 mm. The genital papillae are very prominent, the entire lateral border on the pore side being much more sharply convex than on the aporal side. They are situated in the middle of the segment and in gravid segments may attain a diameter of over 1 mm. and an elevation of 750  $\mu$

Calcareous corpuscles are numerous in the neck and less so in the head.

*Male genitalia.*—There are about 300 testes visible in stained toto mounts. Near the middle of the segment they are scattering and are commonly elongated in the transverse axis of the worm (fig. 38); in that part of the median field adjoining the longitudinal canals they are crowded close together and appear to be of more irregular outline and looser texture. The testes decrease in number toward the median stem of the uterus, but only occasionally leave a narrow clear field at this point, two or three testes usually occupying this field. Along the lateral portion of the median field they form a confused mass which presses in on the ovaries laterally, but does

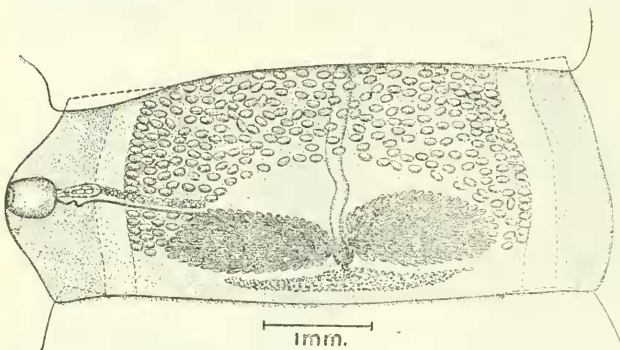


FIG. 38.—TAENIA OVIS. MATURE SEGMENT. AFTER RANSOM, 1913.

not extend posterior of the ovaries or the vitellarium. The testes crowd close to the vas deferens and the vagina, leaving only a narrow free field in that region with an occa-

sional testis occurring in this field. Anterior of the ovaries the testes leave a free semicircular space, the ends of the semicircle following approximately the antero-lateral borders of the ovaries. The vas deferens begins at a little distance from the median stem of the uterus on the pore side and extends to the cirrus pouch in a series of somewhat irregular loops, an occasional loop in some segments crossing the vagina. The cirrus pouch is 450 to 550  $\mu$  long, the inner end being near the outer margin of the ventral excretory vessel.

*Female genitalia.*—The ovaries (fig. 38) are of notably loose and open texture, the one on the aporal side of the segment being the larger and frequently extending a projecting portion anteriorly and medially. The ovaries are elongated in the transverse axis of the segment and are concave on the median face, inclosing as a rule a rather circular interovarian space. The vitellarium is a very open reticular structure, elongated in the transverse axis of the segment, not extending as far laterally as the ovaries and very little or not at all between the ovaries. The reticulations of the vitellarium are also uniformly elongated along the transverse axis of the segment. The shell gland is small and distinct, and not in apparent

contact with the vitellarium. The vagina has usually a slightly sinuous course in the lateral field of the segment, but after crossing the longitudinal excretory canals it extends medially in a rather straight or but slightly curved course and either barely clears the anterior margin of the nearest ovary or crosses the anterior portion of this ovary, a quite unusual and distinctive feature. In gravid segments (fig. 39) the median uterine stem bears on each side 20 to 25 lateral branches, which in turn send out numerous secondary branches which frequently fuse. The eggs are oval, 30 to 34  $\mu$  long by 24 to 28  $\mu$  wide.

*Hosts.*—Primary: *Canis familiaris*. Secondary: *Ovis aries*, *Capra hircus*.

*Location.*—In small intestine of primary host. Embedded in the heart, voluntary muscles, esophagus, lungs, walls of stomach (?), and kidneys (?) of secondary hosts.

*Localities.*—England, France, Germany, Algeria, German Southwest Africa, New Zealand, and the United States.

*Life history.*—Eggs developed by the adult worm in the intestine of the primary host pass out and are ingested in contaminated food or water by the secondary host. In the digestive tract of the secondary host the embryos escape and bore their way into the muscles and other suitable portions of the host's anatomy and finally come to rest and develop to the bladderworm stage, called *Cysticercus ovis*. On the ingestion of these larvae by the primary host the head of the bladderworm develops segments and forms the strobilate tapeworm.

The evidence to the effect that the larvae of this parasite are widely distributed over the world and that they have been overlooked in

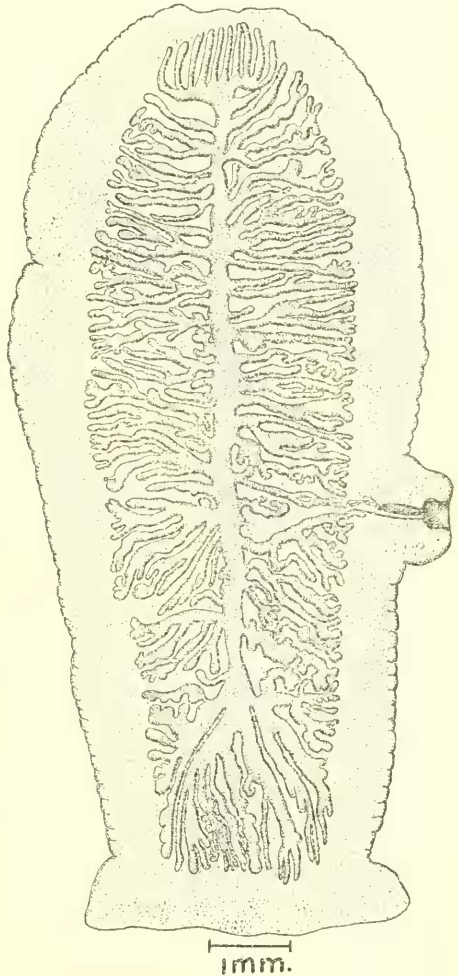


FIG. 39.—*TAENIA OVIS*. GRAVID SEGMENT. AFTER RANSON, 1913.

meat inspection in this and other countries indicates that this is a fairly common tapeworm of dogs, and possibly of other carnivores, that has somehow been overlooked until Ransom (1913) called attention to it. It is quite possible that it has been confused with *T. hydatigena*, though the macroscopic and microscopic differences between these forms are considerable and very evident when once pointed out. The distinctive feature in this species is the crossing of the ovary by the vagina on its way from the segment margin to the interovarian field.

**TAENIA KRABBEI** Moniez, 1879c.

*Specific diagnosis.*—*Taenia*: The head is very small, about 500  $\mu$  in diameter, presenting a generally spherical appearance when viewed from the side and a square outline when viewed en face. The rostellum bears a double crown of 26 to 34 hooks. The large

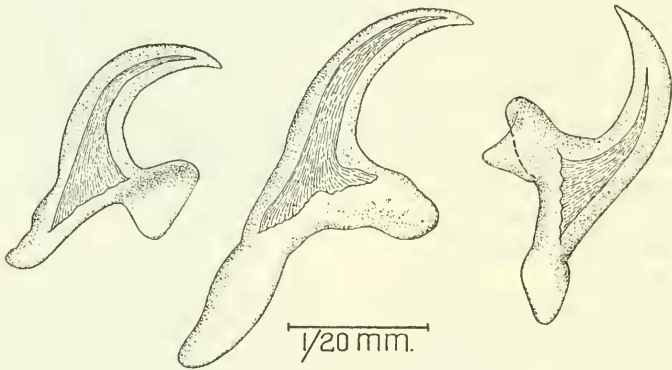


FIG. 40.—*TAENIA KRABBEI*. LARGE AND SMALL HOOKS.

hooks (fig. 40) are 148 to 170  $\mu$  long. The blade is of moderate curvature; the handle is strikingly polymorphic, either straight, curved in a simple curve, with the convexity of the curve dorsal or ventral, or wavy, may have its sides approximately parallel or may taper or thicken toward the distal extremity, may be slightly or deeply notched on the dorsal border or not at all notched; the guard is generally cordiform to oval. The small hooks are 85 to 120  $\mu$  long. They have a blade of strong curvature; the handle is tapering, straight or somewhat curved, but in either case with a tendency to curve dorsally at the tip; the guard is cordiform to oval in lateral view and has usually a slight median groove. The suckers are inconspicuous. The neck is narrow and distinct and appears to be about 1 mm. long in the cotype specimen. The strobila (fig. 41) attains a length of over 26 cm. and a maximum width of over 1 cm. All segments, except the few (7 or 8) terminal gravid segments are very much wider than long, segments 8 mm. wide being about 1

mm. long. Terminal gravid segments are 4 to 5.5 mm. long and 3.5 to 4.5 mm. wide. The genital papillae are extremely large, occupying practically the entire lateral margin of a segment, except in the terminal gravid segments, and attaining a diameter of about 1 mm.

*Male genitalia.*—The cirrus pouch is elongate piriform and apparently does not extend to the lateral excretory canals.

*Female genitalia.*—Vagina often pigmented. Median stem of the uterus has about 10 lateral branches on each side. Eggs relatively small.

*Hosts.*—Primary: *Canis familiaris*. Secondary: *Rangifer tarandus* (*Tarandus rangifer*).

*Location.*—In intestine of primary host. In voluntary musculature of secondary host.

*Locality.*—Iceland, Alaska.

*Life history.*—Eggs produced by the adult worm in the intestine of the primary host pass out and are ingested by the secondary host in contaminated food or water. In the digestive tract an embryo is released and makes its way to the musculature and heart of the host animal. Here it develops to the larval stage, known as *Cysticercus tarandi*. On the ingestion of this bladderworm by the primary host, the caudal vesicle digests and the head develops segments forming the strobilate worm.

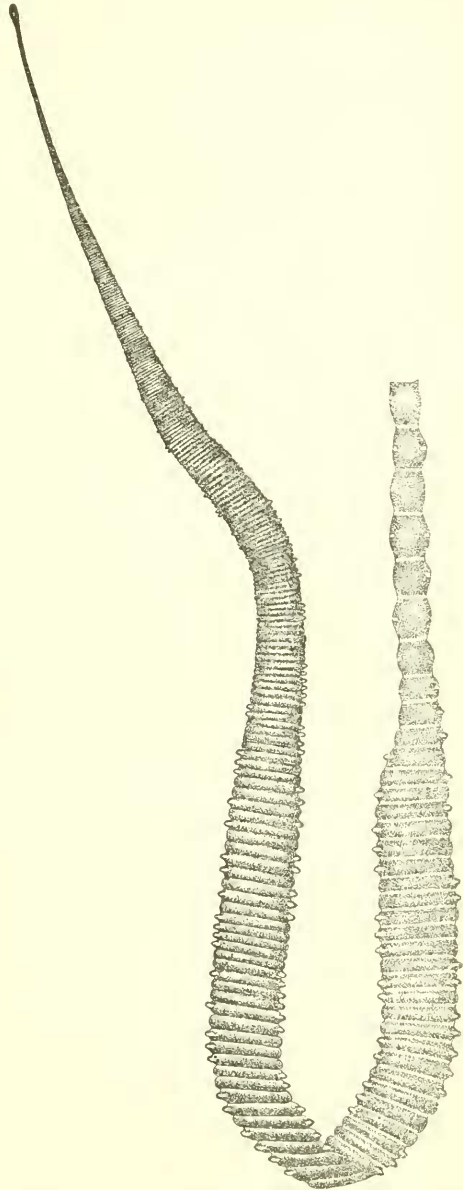


FIG. 41.—TAENIA KRABBEI. ENTIRE STROBILA. ACTUAL SIZE. AFTER MONIEZ, 1880.

The internal anatomy of this tapeworm is not described in detail. In connection with the presence of the parasite in reindeer in Alaska, Doctor Ransom, chief of the Zoological Division of the United States Bureau of Animal Industry, will later publish a study supplying a description of the internal anatomy.

**TAENIA MONOSTEPHANOS** von Linstow, 1905cc.

*Synonym.*—*Taenia laticollis* Rudolphi of von Linstow, 1903u.

*Specific diagnosis.*—*Taenia*: Head with a rostellum armed with a single crown of 29 hooks. These hooks (fig. 42) are from 190 to 210  $\mu$  long and are shaped like rose-thorns, the handle shortened down to approximately the length of the guard or shorter. The strobila is 14.5 cm. long and attains its maximum width near its middle, where it is 2.86 mm. wide. The segments in the middle are wider than long; the terminal segments are longer than wide, 2.57 mm. long and 2.09 mm. wide. Mature segments are 0.99 to 1.18 mm. long and 2.25 mm. wide. The lateral margin of the strobila is serrate. The genital papillae are somewhat posterior of the middle of the lateral margin of the segment. The calcareous corpuscles are very numerous and partly pigmented black. The cuticular layer is thick and is separated from the medullary layer by a sheet of transverse muscles.



FIG. 42.—*TAENIA*  
*MONOSTEPHANOS*.  
HOOK.  
ENLARGED.  
AFTER VON  
LINSTOW, 1903.

*Male genitalia.*—The testes lie in the medullary layer of the segment wherever there are no female organs; they are 78  $\mu$  in diameter and are surrounded by a hyaline layer. The club-shaped cirrus pouch is 570  $\mu$  long, the cirrus is 290  $\mu$  wide and lies free in the genital sinus (?). The vas deferens is rolled in coils in the genital sinus (?).

*Female genitalia.*—The ovaries are fan-shaped and are composed of cells 13  $\mu$  in diameter and provided with large nuclei. The vitellarium is small, elongated along the transverse axis of the strobila and is composed of cells 7.8  $\mu$  in diameter and provided with brightly staining nuclei. The shell-gland is anterior of the vitellarium and is 160  $\mu$  in diameter. The vagina is 34  $\mu$  wide and terminates in a receptaculum seminis 110  $\mu$  long. The median stem of the uterus has numerous lateral branches which in turn send out secondary branches. The eggs are thick-shelled and are 29 to 36  $\mu$  in diameter.

*Host.*—Primary: *Lynx lynx* (*Felis lynx*). Secondary: Unknown.

*Location.*—In small intestine of primary host.

*Locality.*—Russia.

This species was first reported by von Linstow as *Taenia laticollis*, but as he later noted that Rudolphi's description and that of Leuckart

called for the presence of the customary double crown of hooks, he described this form as a new species. If von Linstow's material is to be regarded as actually representative of the normal morphology of the species to which it belongs, then it should be given generic or sub-generic rank on the basis of the single crown of hooks, which is, if anything, more striking than the entire absence of hooks in *Taeniarhynchus saginatus*, *T. africanus*, etc., since the causes which might operate to abolish one row of hooks in the genus *Taenia* s. s. might reasonably be expected to abolish an intercalated row at the same time. It has not seemed advisable to create a new genus for this species for the reason that new data should be added in confirmation of the idea that the conditions reported were normal. It is not an uncommon thing to find specimens of tapeworm in which all the hooks are missing. It sometimes happens that a single row is missing, and the writer (Hall, 1910) reported the loss of the large hooks as a common feature of *Taenia balaniceps*. In both cases, whether one or both rows of hooks are missing, it appears to be usually the result of trauma. What the nature of this traumatic injury may be is uncertain, but even in mounting specimens hooks will occasionally be detached. Railliet (1893) has noted that Leidy has described a specimen of *Taenia pisiformis* provided with a single circlet of hooks (variety  $\alpha$  *monostephana* Diesing), that Bremser has described one without hooks (variety  $\beta$  *astephana* Diesing), and states in comment that these facts are not important and that they deal with material carelessly collected, or very old, or deteriorated material. There are, therefore, grounds for suspecting that the presence of a single row of hooks may be deemed accidental. It may be urged that there is correlated with this an unusual hook shape, consisting of a considerable reduction of the handle. This condition differs only in degree from that in other tapeworms where the handle is short and stubby. Without regarding it as at all impossible that *T. monostephanos* may prove to have a single row of hooks as a normal structure, the possibility that this may not prove to be the case makes it advisable to leave the matter as it stands and wait for further data.

The reason for including this species in a paper on the tapeworms of North America is that we have probably more information about the tapeworms of the lynxes than of any other of our wild North American carnivores, and a note of parasites found in other continents serves to aid in securing a really adequate study of the parasites of our native species.

Genus MULTICEPS Goeze, 1782a.

*Synonyms*.—*Taenia* Linnaeus, 1758a, part; *Cerebrina* Acharius, 1782; *Hydatigena* Goeze, 1782a, of Batsch, 1786a; *Vesicaria* Schrank,

1788a; *Hydatula* Abildgaard, 1790a, part; *Hydatis* Virey, 1798a, part; *Polycephalus* Zeder, 1800a; *Coenurus* Rudolphi, 1808a; *Polycephops* Rafinesque, 1815a; *Multiplex* Liautard in Hall, 1911 (reviewer's error). (For additional synonyms, see Hall, 1910.)

*Generic diagnosis.*—*Taeniinae*: Strobilate stage similar to that of genus *Taenia*. Large hooks usually with a sinuous handle. The vagina usually shows a reflexed loop in the vicinity of the lateral excretory canals. Larval stage a coenurus, a bladderworm with a parent vesicle to which are attached numerous heads, internal or external daughter bladders being present or absent.

*Type-species.*—*Multiceps multiceps* (Leske, 1780a) Hall, 1910.

KEY TO SPECIES OF MULTICEPS.

1. Mature segments wider than long; the lateral margins of each segment at times scalloped as a result of a number of constrictions or furrows passing around the segment transversely; the posterior margin of each segment prolonged posteriorly to overlap the anterior margin of the succeeding segment like a cuff. Small hook with short, blunt curving handle. Genital papilla very narrowly conical and near posterior margin of segment. Larva a coenurus with daughter bladders, found in the connective tissue of rodents.....*Multiceps serialis*, p. 51.

Mature segments longer than broad; the lateral margins of each segment smooth and not scalloped; the posterior margin of each segment prolonged very little or not at all to form a projection over the following segment. Small hooks with long slender handle. Genital papilla posterior of middle of segment but not near posterior margin. Larva a coenurus without daughter bladders, found in ungulates, especially ruminants.....2.

2. Small hook with long curving handle terminating in a narrow distal extremity. Large hook with tapering handle with sinuous outline. Testes do not extend posterior of the ovaries to the vicinity of the vitellarium or between the vitellarium and the ovaries. Larva a coenurus in the central nervous system of ungulates, especially ruminants.

*Multiceps multiceps*, p. 40.

Small hook with long straight handle terminating in a blunt distal extremity. Large hook with the handle not tapering, and either straight and blunt or bent dorsally just at the tip. Testes extend posterior of ovaries almost to the vitellarium and between the vitellarium and the ovaries. Larva a coenurus in the central nervous system, lungs, parenchymatous organs and connective tissue of ruminants.....*Multiceps gaijeri*, p. 45.

MULTICEPS MULTICEPS (Leske, 1780a) Hall, 1910.

*Synonyms.*—*Taenia multiceps* Leske, 1780a; *Vermis vesicularis socialis* Bloch, 1780a; *Taenia vesicularis cerebrina* Goeze, 1782a; *Hydatigena cerebralis* Batsch, 1786a; *Vesicaria socialis* (Bloch, 1780a) Schrank, 1788a; *Taenia cerebralis* (Batsch, 1786a) Gmelin, 1790a; *Polycephalus ovinus* Zeder, 1803a; *Coenurus cerebralis*



(Batsch, 1786a) Rudolphi, 1808a; *Polycephalus coenurus* Tschudi, 1837a; *Taenia multiplex* Leuckart, 1852b; *Taenia coenurus* (Tschudi, 1837a) Küchenmeister, 1853c; *Multiplex multiplex* (Leuckart, 1852b) Liautard in Hall, 1911 (reviewer's error). (For additional synonyms, see Hall, 1910.)

*Specific diagnosis.*—*Multiceps*: The head is piriform in lateral view and presents a square outline when viewed en face, and is about 800  $\mu$  in diameter. The weakly developed rostellum is about 300  $\mu$  in diameter and bears a double crown of 22 to 32 hooks. The large hooks (fig. 43) are 150 to 170  $\mu$  long. The blade has only a slight curvature; the handle is straight in its general direction, its dorsal and ventral borders sinuous and subparallel, commonly notched on the dorsal border at a point between the middle of the handle and the union with the blade, tapering more or less toward the distal extremity and tending to turn dorsally at this extremity; the guard is subcylindrical proximally and more or less conical distally, usually with a slight thickening at the union of the proximal and distal portions. The small hooks are 90 to 130  $\mu$  long. They have a blade of moderate to strong curvature: the handle is relatively long and tapering, usually curved, with the convexity on the dorsal side, along most of its length and with the distal extremity turning dorsally; the guard, in lateral view, is usually subcylindrical in the proximal portion and irregularly rounded conical distally, the thickest point being at the union of the proximal and distal portion, and is slightly grooved in the median line in a way which gives the hook in some views the appearance of being bifid. The suckers are located at the corners of the head and have a diameter of 290 to 300  $\mu$ . There is a distinct neck which may be 2 to 3 mm. long from the posterior margin of the suckers to the first distinct segmentation. The strobila (fig. 44) attains a length of 40 to 100 cm., and consists of 200 to 250 thin and relatively translucent segments, with a maximum width of about 5 mm. The genital primordia appear rather late and the first things to stain clearly in toto mounts are the genital pore and the genital canals from the genital pore inward. The pores are distinct about 4.7 cm. back of the head, in about the eighteenth segment. The segments are mature about 10 to 18 cm. back of the head, the first mature segment being about the one hundred and twenty-fifth. The mature segments (fig. 45) are either square or oblong and longer than wide, but not wider than long. Mature segments have gently

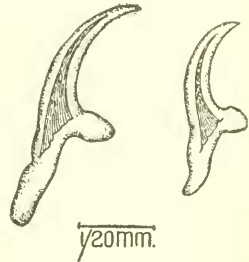


FIG. 43.—MULTICEPS MULTI-CEPS. LARGE AND SMALL HOOKS.

convex lateral margins. There are from 12 to 20 gravid segments, from 6 to 11 mm. long and 3 to 5 mm. wide, usually not over 4 mm. The calcareous corpuscles are very small, 15 to 16  $\mu$  in diameter. The longitudinal excretory canals are small, the ventral lying about 420  $\mu$  from the margin of the segment. The genital papilla is rather flat, but is quite distinct as a result of the translucency of this worm.

*Male genitalia.*—There are about 200 testes in one horizontal plane. They are principally confined to the lateral portions of the

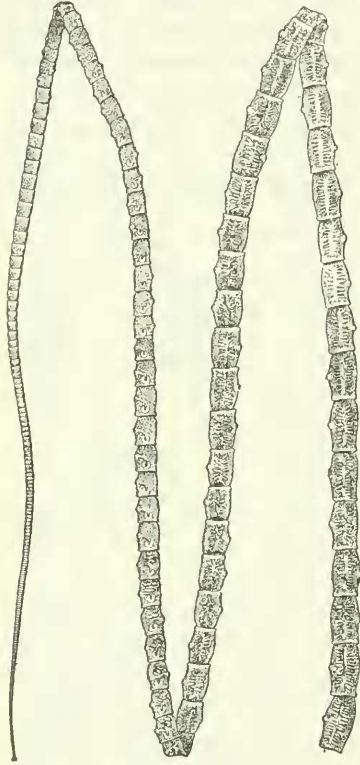


FIG. 44.—MULTICEPS MULTICEPS. ENTIRE STROBILA. ACTUAL SIZE. AFTER HALL, 1910.

median field near the longitudinal canals, a few scattering testes occupying a more median position anteriorly, but leaving a fairly wide and distinct field about the median stem of the uterus (fig. 45). The testes do not press close to the field of the vas deferens and vagina, and leave a fairly wide free field on each side of these canals. They extend alongside of the ovaries but do not press close to them and do not pass posterior of the ovaries in the direction of the vitellarium. The testes are practically confined to the fields lying lateral of lines drawn parallel to the longitudinal axis of the strobila through the lateral edges of the ovaries. The vas deferens originates close to the median stem of the uterus on the pore side of the segment and extends in a series of loops to the cirrus pouch. The cirrus pouch usually originates in the field lateral of the longitudinal excretory canals and is either curved, with the convexity of the curve toward the anterior portion of the segment, in which case the vagina follows the curve on the concave posterior side, or is straight and more or less piriform

or cylindrical, in which case the vagina comes in from the genital eminence to about the middle of the cirrus pouch and then bends off at a right angle or even turns back toward the lateral margin for a short distance. The cirrus pouch is 315 to 350  $\mu$  long and is 110 to 145  $\mu$  wide.

*Female genitalia.*—The ovaries are somewhat elongated along the longitudinal axis of the strobila and inclose an interovarian field

that is truncate conical to somewhat conical in shape (fig. 45). They are very nearly equal in size. The vitellarium is small, triangular, and of reticular structure and rather widely set off from the other male or female genital glands. The median point may or may not project slightly between the ovaries but the vitellarium does not extend laterally as far as the ovaries. The shell-gland is small, distinct, and lies in the clear. The vagina follows the conformation of the vas deferens, as noted above in the discussion of the male genitalia, and then curves in around the nearest ovary to the receptaculum seminis in the interovarian field. In the transition from mature to gravid segments, a striking feature is the almost constant forma-

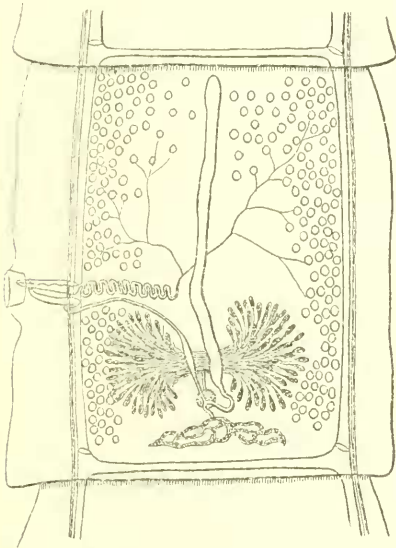


FIG. 45.—MULTICEPS MULTICEPS. MATURE SEGMENT. ENLARGED. AFTER DEEFKE, 1891.

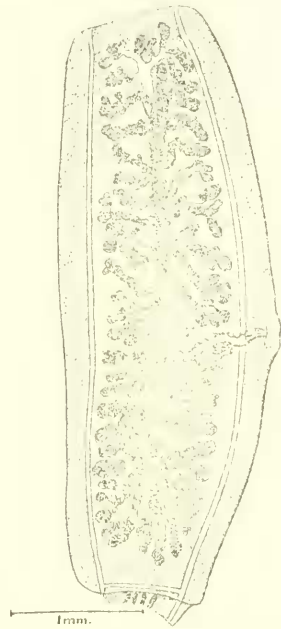


FIG. 46.—MULTICEPS MULTICEPS. GRAVID SEGMENT. AFTER HALL, 1910.

tion of two lateral branches, one on each side, between the ovary and the vitellarium. In gravid segments (fig. 46), the median stem of the uterus has from 9 to 26 lateral branches, rather distinctly parallel to one another for the most part, and most of these in turn giving rise to a very few secondary branches, which usually remain quite distinct and without tendency to fuse. The eggs are from 29 to 37  $\mu$  in diameter and have a shell 4  $\mu$  thick.

*Hosts*.—Primary: *Canis familiaris*, *C. nebracensis*. Secondary: *Ovis aries*, *Bos taurus*, *Capra hircus*, *Equus caballus*, chamois, mouflon, gazelle, antelope, African antelope, *Bubalis* sp., *Ozanna equina* (*Hippotragus equinus*), *Homo sapiens*.

*Location.*—In small intestine of primary host. In central nervous system, brain or spinal cord, of secondary host.

*Localities.*—Greece, Germany, Switzerland, England, France, Italy, Ireland, Holland, Scotland, Austria, Denmark, Iceland, Argentine Republic, Sardinia, South Australia, New Zealand, German South-west Africa, India, Hungary, Cape Colony, Chile, Spain, Shetland, Algeria, United States.

*Life history.*—Eggs developed by the adult worm in the intestine of the primary host pass out and are ingested in contaminated food or water by the secondary host. In the digestive tract an embryo is released and bores its way through the tissues and into the blood stream. An embryo which attains the central nervous system will develop and form a coenurus which, unless removed by surgical interference, ultimately kills the host animal. The embryos which do not attain the central nervous system begin development, but very soon die and undergo degeneration. On the death of the host animal, as a result of the pressure of the parasite or from other causes, if the developed bladderworm is ingested by the primary host, part, or possibly all, of the heads attached to the bladder may develop segments and form the strobilate worm.

The writer (Hall, 1910) has previously stated that the dog is the only known host of the adult *Multiceps multiceps*. Since that time two records from the coyote (Hall, 1911; Hall, 1912), as a result of experimental feedings, have been published. The writer also stated that he had not found the record of the adult worm in *Alopex lagopus* (*Canis lagopus*) credited to Möbius by Railliet (1893a). Since then the record by Möbius (1874) has been found, but it does not appear to be an acceptable record of *Multiceps multiceps*. The worms in question were 55 to 65 mm. long and had gravid segments, and unless we assume that these figures are an error for 55 to 65 cm., they can not be considered as *M. multiceps*. In other respects the figures agree fairly well with *M. multiceps*—95 to 113 segments; head 800  $\mu$  wide; a double crown of 26 hooks, the large 160  $\mu$  long and the small 120  $\mu$  long; the segments quadratic two-thirds of the distance from the head and 2 mm. long and wide; the terminal segments 3 mm. long and 2.6 mm. wide; uterus with 12 to 16 lateral branches; maximum egg measurements 31.5 by 27.4  $\mu$ . He states that the shape of the hooks agrees with those of *M. multiceps*. The size of the terminal segments is not quite that of *M. multiceps*, but as there appears to be some possibility of error in the figures given for the strobila, there may also be some in those for the segments. The writer further stated, in the paper noted above, that there were no satisfactory records of larval *M. multiceps* from man. Brumpt (1913) has since

recorded a case in which he gives data and figures that must be accepted as a case of this parasite from the brain of man.

MULTICEPS GAIGERI Hall, 1916.

*Synonym.*—*Coenurus serialis* Gervais, 1847a, of Gaiger, 1907, and Dey, 1909.

*Specific diagnosis.*—*Multiceps*: The head is somewhat piriform in lateral view and almost square when viewed en face, and is about 950  $\mu$  in diameter. The weak rostellum is about 360  $\mu$  in diameter and bears a double crown of 28 to 32 hooks. The large hooks (fig. 47) are 160 to 180  $\mu$  long. The blade is of slight curvature; the handle is nearly straight or only slightly sinuous, with usually a notch, slight or very pronounced, on the dorsal border between the middle of the handle and the union with the blade, the dorsal and ventral borders approximately parallel and the handle not tapering but ending bluntly and at times with a slight curvature dorsally at the distal extremity; the guard is approximately cordiform in lateral view, the point of maximum thickness being a short distance from the union with the blade and handle, thus forming a neck proximally and a roundly conical distal portion. The small hooks are 115 to 150  $\mu$  long. The blade is strongly curved; the handle is long, straight, slightly sinuous in outline, and tapering to a rather blunt tip; the guard is rather oval in lateral view, has a slight median ventral depression without being bifid, and meets the handle at a very obtuse angle, almost a straight angle. The suckers are comparatively large, set prominently at the angles of the quadrate head and with relatively small intervals between adjacent suckers, and have a bulb diameter of 310 to 330  $\mu$ . The neck is quite distinct, of smaller diameter than the head, and may measure around 690  $\mu$  in length. The entire strobila may measure from 25 cm. to 1.82 meters, according to conditions and individual development. In a well-developed strobila, about 40 cm. long, the segments become square about the middle of the strobila, being 5 mm. long and 5 mm. wide at a distance of 20 cm. from the head. As the segments become longer than wide they become mature. At 30 cm. from the head they are 7 mm. long and 5 mm. wide. At 40 cm. from the head the segments are 14 mm. long and 2 to 3 mm. wide. The entire strobila is rather

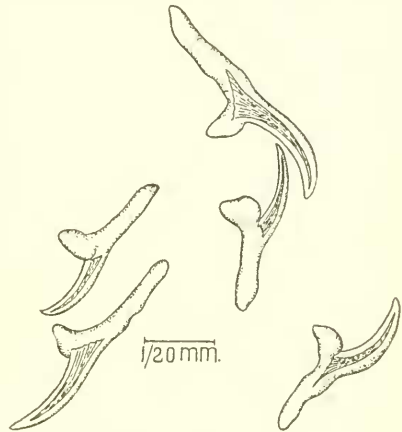


FIG. 47.—MULTICEPS GAIGERI. LARGE AND SMALL HOOKS. FROM HALL, 1916a.

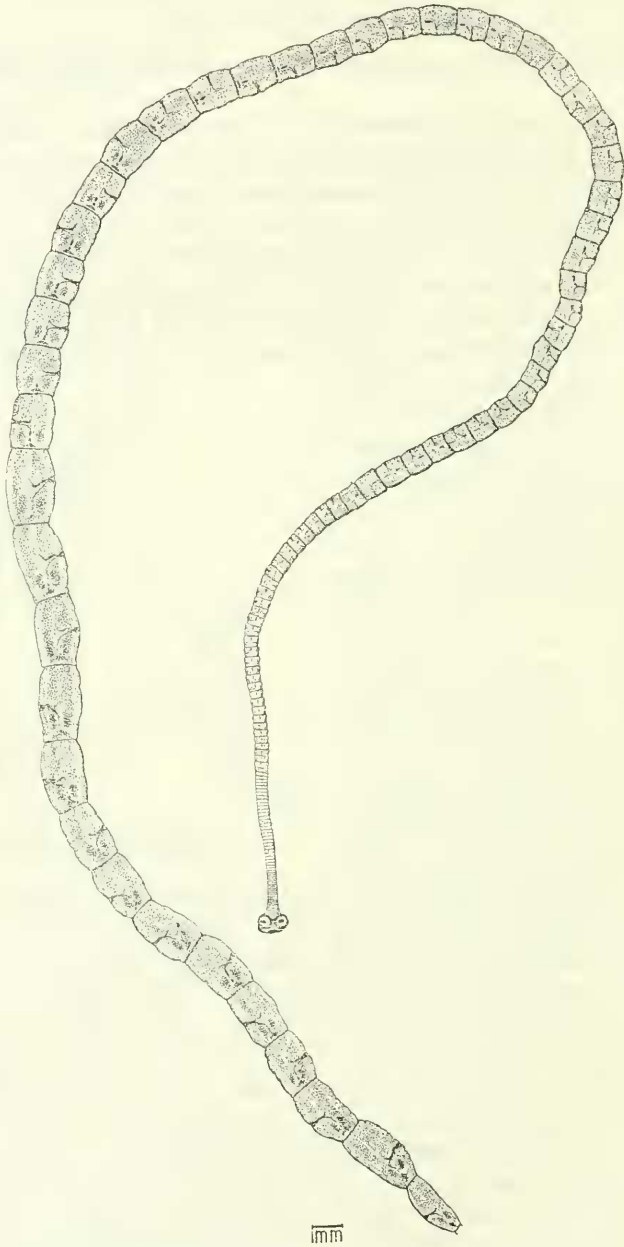


FIG. 48.—MULTICEPS GAIGERI. YOUNG STROBILA. FROM HALL, 1915.

thin, delicate, and comparatively translucent (fig. 48). The genital primordia appear in about the thirtieth segment, between 2 and 3 mm. back of the head, first as deeper staining areas in the median line. These areas become angular, the legs of the angles forming the genital canals. The primordium of the median stem of the uterus is the next thing visible. Calcareous corpuscles are especially large and abundant in the medullary portion of the head and the anterior portion of the neck, where they are elliptical and about 13 by 8  $\mu$  in diameter, but are elsewhere small, oval, about 4 or 5  $\mu$  in length, and, though numerous, are relatively inconspicuous. The longitudinal excretory canals are quite distinct, the ventral canal situated about 225  $\mu$  from the margin of the segment and the dorsal canal lying lateral of this. The genital papilla is flat and inconspicuous, an actual papilla formation being lacking as a rule, but is readily observed, owing to the translucency of the segments.

*Male genitalia.*—There are between 200 and 225 large, irregularly spherical testes, confined principally to the lateral portions of the median field in the vicinity of the longitudinal excretory canals (fig. 49). There is a wide field about the median stem of the uterus which is free or comparatively free from testes, only an occasional two or three occurring here. The field about the vas deferens and vagina is also comparatively free from testes for some distance on each side.

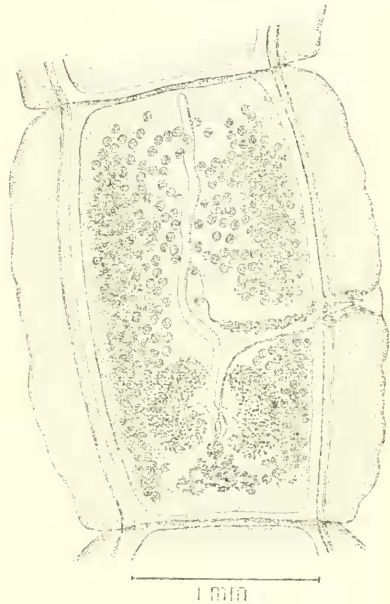


FIG. 49.—MULTICEPS GAIGERI. MATURE SEGMENT.  
FROM HALL, 1916a.

The testes press close to and even in contact with the lateral borders of the ovaries and also extend to the vitellarium and between the vitellarium and the ovaries. The vas deferens begins close to the median stem of the uterus on the pore side and first extends at an angle posteriorly and laterally. It is very much looped from its origin, the loops extending widely along the longitudinal axis of the worm, even across the vagina, and also back and forth along the general path of the vas deferens, the loops being so numerous as to form a dense wide structure. The cirrus pouch extends to the median border of the ventral excretory canal. It is piriform to elongate elliptical in shape, often with a concavity on the posterior side, toward the vagina, and about 260  $\mu$  long by 100 to 125  $\mu$  wide.

*Female genitalia.*—The ovaries (fig. 49) are elongated along the longitudinal axis of the strobila, of the same size, and reniform to fan-shaped, the interovarian field varying correspondingly from oval to almost quadrilateral. The vitellarium is roughly triangular in outline, the anterior angle projecting a short distance into the interovarian field and occasionally suppressed at this point to form a truncated or even invaginated structure for the reception of the shell-gland. The vitellarium is

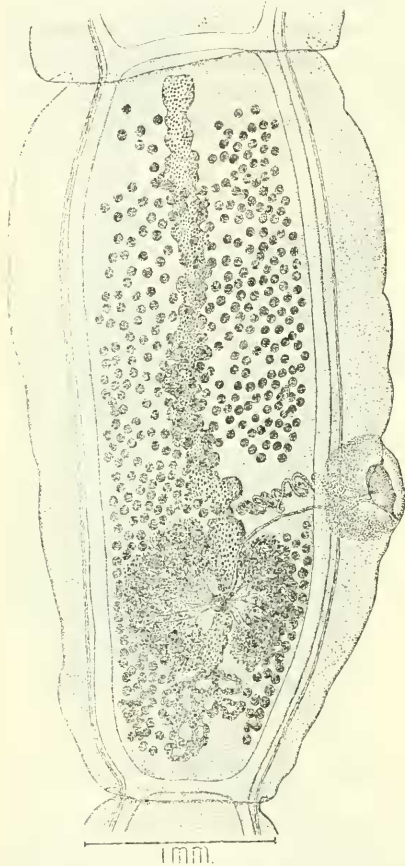


FIG. 50.—MULTICEPS GAIGERI. MATURE SEGMENT SHOWING THE OCCASIONAL ELONGATION OF THE VITELLARIUM ALONG THE LONGITUDINAL AXIS OF THE STROBILA. FROM HALL, 1916a.

often irregular or asymmetrical and in some segments may even be elongated along the longitudinal axis of the strobila, a quite distinctive feature (fig. 50). The vitellarium does not extend laterally as far as the ovaries do. The shell-gland is comparatively large, at times distinctly in the clear near the anterior apex of the vitellarium and at times apparently in contact with the vitellarium or occupying an invagination at the anterior apex of the vitellarium. The vagina follows the general contour of the portion of the cirrus pouch lying nearest the lateral margin of the segment, being straight when the cirrus pouch is straight and following the concavity when the pouch is concave posteriorly. It then bends abruptly, usually at right angles, but at times at an obtuse angle or again at an acute angle back toward the margin of the segment. It then turns medially and after pursuing a short wavy course, with usually two crests, or even

making another loop, it swings in a wide curve around the nearest ovary to the receptaculum seminis in the interovarian field. In gravid segments the median stem of the uterus is very wide and has from 12 to 15 wide lateral branches which in turn send out wide secondary branches. The median field of the narrow segments is thus reduced to nearly a solid mass of eggs, the space between the wide uterine areas being very small. The eggs are nearly spherical and are 25 to 30  $\mu$  in diameter.



*Hosts.*—Primary: *Canis familiaris*. Secondary: *Capra hircus*.

*Location.*—In small intestine of primary host. In central nervous system, liver, lungs, spleen, kidney, bladder, intermuscular connective tissue, under peritoneum and subcutaneous in secondary host.

*Locality.*—India (Punjab, at Lahore, and Bengal) and Ceylon.

*Type-material.*—U. S. National Museum No. 16590. (Bureau of Animal Industry Helminthological Collection.)

*Life history.*—Eggs produced by the adult worm in the primary host pass out and are ingested by the secondary host in contaminated food and water. In the digestive tract the embryo escapes from its shell and migrates into the tissues of the host, where it develops into a coenuriform larva. On ingestion of this larva by the primary host, some or all of the heads attached to it may give rise to strobilate worms in the intestine.

Gaiger (1907) first recorded this parasite from the goat at Lahore, India. He had two cases of the larval parasite occurring in the connective tissue, and because of the site of the worm and the presence of what he regarded as daughter cysts, he concluded that the parasite was *Multiceps serialis*, the form commonly found in the connective tissues of the rabbit, rather than *M. multiceps*, the form commonly found in the central nervous system of ungulates. He fed some cyst material to a dog and to a rat. The rat died in two days and the hooks were recovered from the stomach. The dog began passing segments of tapeworm on the fourteenth day and was killed on the thirty-first day. The small intestines were found packed with tapeworms from 1 to 40 cm. long.

Two years later, Dey (1909) reported this parasite from the goat in Bengal, India. In this case the parasites were found in the brain, intermuscular connective tissue, in subcutaneous situations, and in the mesenteries and attached to the peritoneum of the abdominal wall and the serous covering on the viscera. A dog was first treated with taeniocides and purgatives and then fed some cyst material. In a month and a half the dog began passing segments of tapeworm and was killed two weeks later. Seventy-five tapeworms, the longest 1.82 meters long, were recovered from the small intestine, and the scolices found to agree with those of the coenurus.

Southwell (1912) reports *Coenurus serialis* from the goat and *Taenia serialis* from the dog in Ceylon. The record from the goat must be regarded as a record of *M. gaigeri*, and that from the dog may be.

Gaiger (1915) lists it from the goat in India with a note to the effect that it is common.

In a previous paper (Hall, 1910*b*), Gaiger's and Dey's records of *M. serialis* from the goat were provisionally accepted as correct, with

a note to the effect that the parasite would receive further attention later. Through the courtesy of Doctor Gaiger, specimens of the coenurus from the goat and of the tapeworm from the dog were furnished to the United States Bureau of Animal Industry, and an examination of these showed them to be a new species. That there are no rabbits in India, a fact Gaiger (1909, 530) has himself noted, would suggest something of the sort. The specimens of the adult worm are much smaller than the largest specimens noted by Dey, but as the size depends largely on whether fresh material is measured in a stretched condition or preserved material is measured on a flat surface this is a small matter. In the specimen which I have designated as type, the segments are mature about 5.5 to 6.5 cm. back of the head. The general anatomy of the species is much more nearly that of *M. multiceps* than *M. serialis*. The strobila is delicate and the vagina shows a peculiar bend which is strongly suggestive of the condition in *M. multiceps*. The hooks are also suggestive of *M. multiceps*. Gaiger states that the small hook has a bifid guard, but this statement is often made of tapeworms that do not have a bifid guard. In these cases, as in this species, there is an appearance of bifidity found on focusing which is due to the fact that the lateral margins of the guard are commonly thickened and the median ventral portion thinned and often slightly grooved, but such conditions must be differentiated from the condition of true bifidity which is found in such hooks as those of *Taenia pisiformis*.

An examination of the larva shows it to be more closely related to *M. multiceps* than to *M. serialis* morphologically. Placed in a dish with typical specimens of these species it resembles the former much more than the latter, and the same is true of scolices detached from all three species. Gaiger (1907) states "there was a very distinct tendency in most cysts towards budding off of daughter cysts, and although actual separation of a daughter cyst was not seen, in one case there was a distinct neck dividing off a portion of the parent cyst. Internal budding was complete and many of the cysts were floating free. The daughter cysts were never more than 2 mm. broad and 4 long, and were always egg-shaped with one head at the narrow end. The majority of them were attached by a minute pedicle to the parent cyst, but could be easily detached, and often they were present in bunches, both attached and free." I find on examination that a striking feature of this species, so far as the available material is concerned, is the extraordinary ease with which the heads detach from the bladder wall and so come to lie free in the internal fluid. The great majority of the heads in the available specimen are free and lie in a mass inside the bladder, their former position being marked by neat prominent apertures perforating the bladder wall. This is the obvious explanation of Gaiger's statement

regarding daughter bladders. These are deciduous scoleces, but they are not daughter bladders. It is interesting to note that we have here a condition suggestive of what must have been the origin of daughter bladders, namely, a deciduous scolex, but it is so recent a development here that the cyst has not yet developed a reparative process at the site where the scolex separates. This species is apparently intermediate between *M. multiceps* and *M. serialis* in this and other respects. It presents an interesting study from a physiological standpoint in that it is capable of development in the central nervous system and also in the connective tissues and on serous surfaces, thus combining the sites of the other species, and causes the formation of an adventitious capsule, as *M. serialis* does and *M. multiceps*

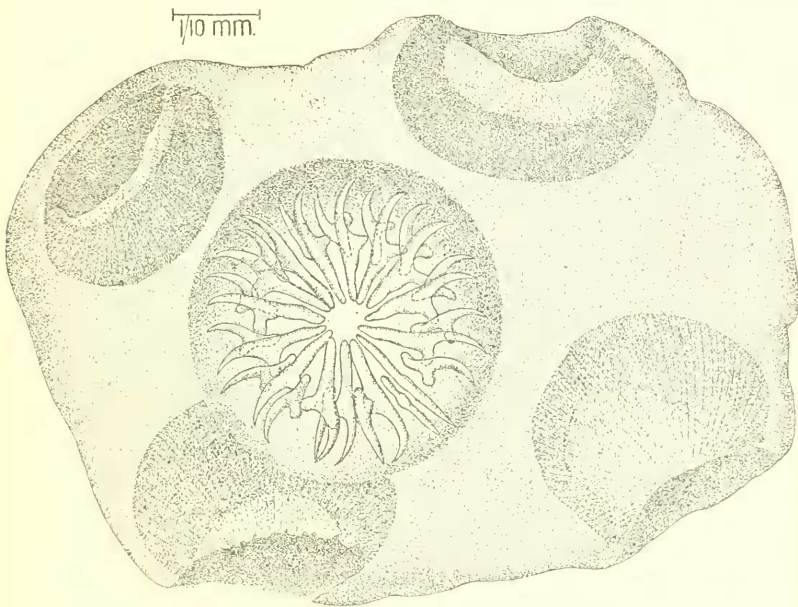


FIG. 51.—MULTICEPS SERIALIS. HEAD VIEWED FROM THE FRONT.

does not, even adhering tightly to the brain, from which *M. multiceps* slips very easily and with no trace of adhesions.

MULTICEPS SERIALIS (Gervais, 1847a) Stiles and Stevenson, 1905a.

*Synonyms*.—*Coenurus serialis* Gervais, 1847a; *Taenia serialis* (Gervais, 1847a) Baillet, 1863a; *Coenurus cuniculi* (Diesing, 1863b) Cobbold, 1864b; *Coenurus lowzowi* Lindemann, 1867a; *Multiplex serialis* (Gervais, 1847a) Liautard in Hall, 1911 (reviewer's error). (For additional synonymy, see Hall, 1910.)

*Specific diagnosis*.—*Multiceps*: The head (fig. 51) is approximately spherical when viewed from the side, but quadrangular when viewed en face, and is 850  $\mu$ . to 1.5 mm. in diameter. The rostellum is

about 390  $\mu$  in diameter and bears a double crown of 26 to 32 hooks. The large hooks (figs. 52 and 53) are 135 to 175  $\mu$  long. The blade is of moderate curvature; the handle is slightly sinuous in outline, frequently tapering slightly and with a tendency to turn dorsally at the distal extremity; the guard is somewhat cordiform in lateral

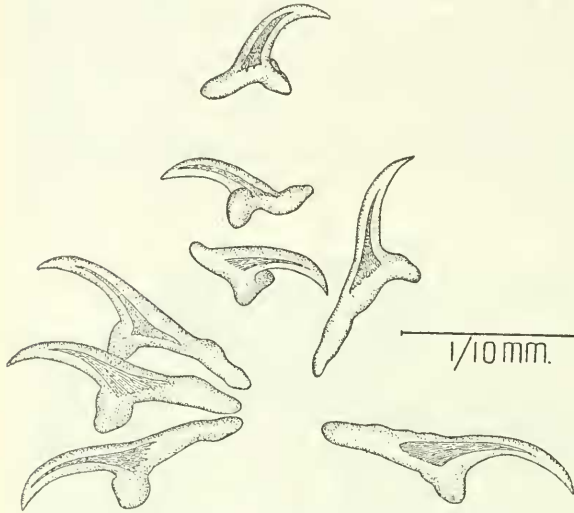


FIG. 52.—MULTICEPS SERIALIS. LARGE AND SMALL HOOKS.

view, the maximum diameter being a short distance from the union with the blade and handle, and with a projection toward the blade along this line of maximum thickness. The small hooks are 78 to 120  $\mu$  long. The blade is of strong to moderate curvature; the handle is short, thick, and curved, the convexity of the curve being ventral; the guard is oval to cordiform and has a median ventral groove. The suckers are large, with a muscular bulb about 300  $\mu$  in diameter, but are set close together and are not conspicuous. The neck is distinct, narrow, almost 1 mm. long and may at times have a sharply defined constriction encircling it. The developed strobila may be from 20 to 72 cm. long, with a maximum width of 3.5 to 5 mm. and is very thick in the dorso-ventral dimension. Mature segments are wider than long, and are between 1.5 and 2 mm. long, and 2.5 and 3 mm. wide. Gravid segments are longer than wide and may be 6 to 12 mm. long and 3 to 4 mm. wide. The outline of the strobila is neither serrate nor smooth, but is uneven as a result of transverse furrows of the segments, the normal convexity of the segments and the prominence of the genital papillae. Calcareous corpuscles are extremely abundant, oval in shape, with a maximum diameter of about 20  $\mu$ , and are a prominent factor in making the strobila very dense and opaque. In young segments the posterior angles of each segment are considerably prolonged, but the prolongation extends posteriorly rather than lat-

ter



FIG. 53.—MULTICEPS SERIALIS. LARGE AND SMALL HOOKS. ENLARGED. AFTER NEUMANN 1892.

erally, and so lies close to the succeeding segment instead of projecting and forming a prominent angle and thus giving a serrate appearance to the strobila. In older segments, the posterior segment margin is prolonged to form an infundibuliform portion which surrounds the anterior portion of the succeeding segment (fig. 54). In a naked eye inspection of the strobila this prolongation is seen as a pale, fairly wide band separating the segments, whereas most related tapeworms show a narrow depression between adjacent segments. The genital papilla is very prominent and is situated posterior of the middle of the segment, sometimes slightly posterior and often very much posterior, even practically at the posterior edge of the lateral border; it is very rarely in the middle of the segment. The genital cone is frequently set very deep at the bottom of the genital pore. The genital primordia appear almost immediately behind the neck as densely staining areas in the median line. Farther back on

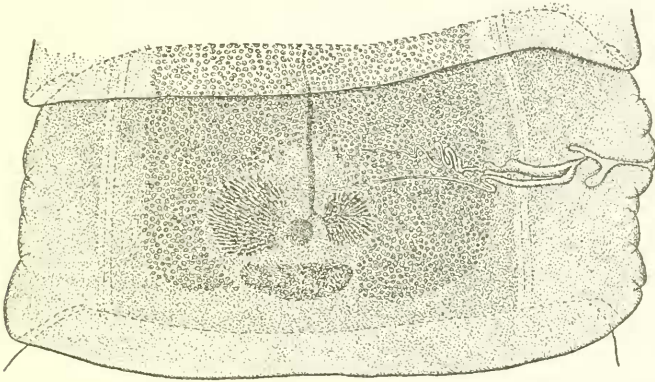


FIG. 54.—MULTICEPS SERIALIS. MATURE SEGMENT. ENLARGED.

the strobila the genital canals and the median stem of the uterus develop as outgrowths from this central area.

*Male genitalia.*—The testes (fig. 54) are numerous and set close together throughout the testicular field. In the segments in which they first appear they do not occur in the field of the median stem of the uterus, but subsequently this field is invaded, as is also the field of the vas deferens and vagina. They extend in intimate contact with the lateral margins of the ovaries to the vitellarium and posterior of the ovaries. Anterior of the ovaries there is an approximately square field free from testes, the lateral testicular fields being connected by a rather straight band of testes crossing the anterior portion of the segment. The vas deferens apparently originates at some distance from the median stem of the uterus on the pore side of the segment and is apparently very little looped. The

cirrus pouch is a very narrow, elongated, nozzle-shaped structure, the distance from the median end of the cirrus pouch to the tip of the very narrowly elongate conical genital eminence being 200 to 300  $\mu$ . and the maximum width, near the median end, 55 to 99  $\mu$ ; the pouch is occasionally bent or curved; it is expanded to contain the few loops of the cirrus only in the median portion. The external

aperture is often on the side, rather than the tip, of the genital cone.

*Female genitalia.*—The ovaries are often of approximately equal size and elongated along the transverse axis of the strobila. The vitellarium is likewise elongated in the same direction; it does not extend laterally as far as the ovaries; in toto mounts it sometimes seems to connect the posterior portions of the ovaries. The shell gland is small and inconspicuous. The vagina comes in from the lateral margin of the segment, presents a reflexed loop, or several loops, near the longitudinal excretory canal and

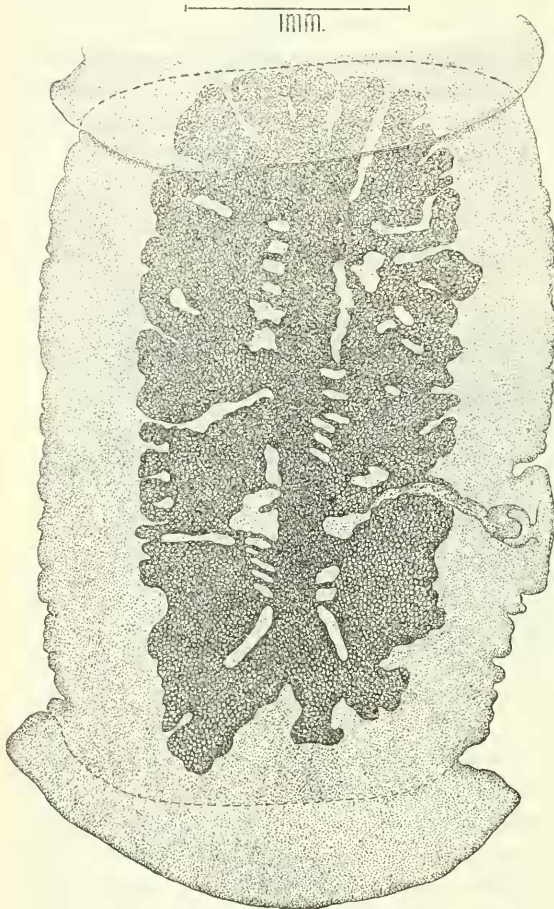


FIG. 55.—MULTICEPS SERIALIS. GRAVID SEGMENT.

curves sharply around the nearest ovary to the interovarian field. In gravid segments (fig. 55) the median stem of the uterus has 20 to 25 lateral branches, or so many branches which in turn send out numerous anastomosing branches that a count is impossible. The entire median field is filled with uterine developments to the point where almost no remaining parenchyma can be detected between the growths. Even in gravid segments the posterior flap of the segments overlaps the anterior portion of the succeeding segment so much as to

distinctly overlap the anterior end of the uterus, whereas in related tapeworms gravid segments show a tendency to become very distinctly separated and constricted at their point of contact with other segments. The eggs are elliptical, 31 to 34  $\mu$  by 29 to 30  $\mu$  in diameter.

*Hosts.*—Primary: *Canis familiaris*. Secondary: *Lepus europaeus* (*L. timidus*), *L. californicus*, *L. c. wallawalla*, *L. c. deserticola*, *L. timidus* (*L. variabilis*), *L. californicus texianus* (*L. texianus*), *L. callotis*, *Oryctolagus cuniculus*, *L. cuniculus domesticus* (*L. cuniculus*), *Sciurus vulpinus* (?), *S. niger neglectus* (*S. vulgaris*), *S. carolinensis* (?), *Myocastor coypus* (*Myopotamus coypus*).

*Location.*—In the small intestine of the primary host. In the connective tissue of the secondary hosts, intermuscular, subcutaneous, etc.

*Localities.*—England, Scotland, France, Switzerland, Italy, Russia, Siberia, Australia, New Zealand, Japan, India, Tunis, and the United States.

*Life history.*—Eggs developed by the adult worm in the intestine of the primary host pass out and are ingested by the secondary host with contaminated food and water. In the digestive tract of the secondary host the embryo escapes and bores into the tissues and possibly into the circulation of the host. In the connective tissue under the skin, between the muscles, and elsewhere, it comes to rest and develops into a larval form, or coenurus, with numerous heads attached and also with the production of internal and external daughter bladders which in turn develop numerous heads. On ingestion of these bladders by the primary host the tapeworm heads develop segments and form the strobilate worm.

The thickness of this worm and the number of calcareous corpuscles make it an unfavorable subject for toto mounts. Unless the calcareous corpuscles are eliminated by the use of some acid, the resulting mounts will be very unsatisfactory, and even after they are eliminated the thickness of the worm makes it a very much less satisfactory mount than such translucent worms as *M. multiceps*, *M. gaigeri*, or even such worms as *Taenia pisiformis*. The description given above is based on specimens furnished to the United States Bureau of Animal Industry through the courtesy of Professor Railliet. Material from North America available to the present writer through the courtesy of Prof. F. D. Barker, of the University of Nebraska, appears to conform in essential respects to the European form.

In a previous paper (Hall, 1910) I have noted that the records of this parasite from the squirrel were probably correct. Since then I have recorded (Hall, 1911) the development of this species in *Sciurus carolinensis*.

In the same paper (Hall, 1910) I stated that the parasite apparently did not occur in Germany. Later information is to the same effect. It would be interesting to know why a parasite which occurs in France, Switzerland, Italy, Russia, and Siberia does not, apparently, occur in Germany, Austria, and Hungary, in spite of the fact that primary and secondary hosts are present in the countries in question, and so far as any one knows, under circumstances presumably as favorable as in the countries in which the parasite is found.

**Genus ECHINOCOCCUS Rudolphi, 1801a.**

*Synonyms.*—*Acephalocystis* Laennec, 1804; *Liococcus* Bremser, 1819a; *Splanchnococcus* Bremser, 1819a; *Echinokokkus* Buhl, 1856a; *Echinococcifer* Weinland, 1858a. (For additional synonyms see Stiles and Stevenson, 1905a.)

*Generic diagnosis.*—*Taeniinae*: Strobila composed of not over four or five segments, of which only the posterior terminal segment is gravid. Head armed with a double crown of hooks. Genital pores marginal and irregularly alternate. Larval stage an echinococcus, a bladderworm with a thick laminated wall and with or without internal or external daughter cysts; brood capsules develop in the mother or daughter cysts and contain several scolices. Adults in carnivorous animals; larval stage in herbivorous and omnivorous animals.



FIG. 56.—ECHINOCOCCUS GRANULOSUS. LARGE AND SMALL HOOKS.  $\times 300$ . AFTER LEUCKART, 1880.

*Type-species.*—*Echinococcus granulosus* (Batsch, 1786a) Rudolphi, 1805a.

**ECHINOCOCCUS GRANULOSUS (Batsch, 1786a) Rudolphi, 1805a.**

*Synonyms.*—*Taenia echinococcus* Siebold, 1853; *Echinococcifer echinococcus* (von Siebold, 1853) Weinland, 1861; *Taenia echinococca* Koeberle, 1861a; *Taenia (Echinococcifer) echinococcus* of Leuckart, 1863; *Taenia (Arhynchotaenia) echinococcus* of Diesing, 1864a; *Taenia echinococcus* von Linstow, 1878; *Taenia (Echinococcus) echinococcus* of Railliet, 1885a. (For additional synonyms, see Stiles, 1906a.)

*Specific diagnosis.*—*Echinococcus*: Head very small, subglobular, scarcely  $300\ \mu$  in diameter. Rostellum prominent, armed with a double crown of 28 to 50 hooklets. The large hooks (fig. 56) are 22 to  $30\ \mu$  long ( $40$  to  $45\ \mu$ , according to Leuckart). They have a blade of very slight curvature, which tends to lie in a prolongation of the longitudinal axis of the handle, and which is very thick at the base; the handle is rather straight, short, and thick, and with dorsal and ventral swellings in the median portion; the guard is excessively shortened and rounded, forming practically a hemispherical protu-



berance. The small hooks (fig. 56) are 18 to 22  $\mu$  long (30 to 38  $\mu$ , according to Leuckart). The blade is very short and very little curved, and tends to lie in a prolongation of the longitudinal axis of the handle; the handle is comparatively long and narrow, with a prominent dorsal swelling near the middle which causes a tapering to the distal extremity; the guard is relatively very much enlarged and oval in outline. The suckers are 130  $\mu$  in diameter and are set well back from the rostellum. The neck attenuates posterior of the suckers and then gradually increases in width to meet the anterior margin of the first segment (fig. 57). This first segment is almost square, about 240 to 260  $\mu$  long and wide, and is sterile. The second segment is about twice as broad in its posterior portion as the first segment and is about four times as long, and is mature. The third segment is gravid and is much larger than the second, attaining a maximum length of about 2 mm. and a width of 600  $\mu$ . The longitudinal excretory canals are visible and calcareous corpuscles are present.

*Male genitalia.*—Testes 70  $\mu$  in diameter and about 40 to 60 to the segment, most of them in the anterior



FIG. 57.—ECHINOCOCCUS GRANULOSUS. STROBILATE TAPEWORM. ENLARGED. AFTER LEUCKART, 1850.

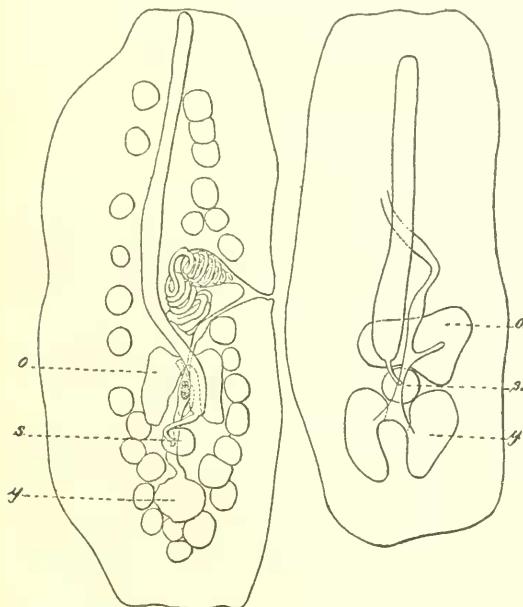


FIG. 58.—ECHINOCOCCUS GRANULOSUS. FRONTAL SECTIONS OF MATURE SEGMENTS. o, OVARY; s, SHELL-GLAND; y, YOLK-GLAND. ENLARGED. AFTER VON ERLANGER, 1890.

and posterior ends and on the aporal side of the median field. The vas deferens originates near the median line of the segment, anterior of the ovary and on the pore side of the median stem of the uterus, and has a few wide coils before entering the cirrus pouch (fig. 58). In its general course it extends diagonally forward to the cirrus pouch, which is about 500  $\mu$  long and extends almost to the median line of the segment.

*Female genitalia.*—

The ovary is horseshoe-shaped (fig. 58), with the median isthmus

narrower than the ends, and the concavity posterior is subme-

dian in position and about halfway between the plane of the genital pore and the posterior border of the segment. The vitellarium is situated near the posterior border of the segment; it consists of two lobes, a dorsal and a ventral, lying one above the other, the lobes in turn being formed of two portions, each with its own duct. The shell-gland is spherical to oval. The ovaries, vitellarium, and uterus have the common openings of their tubes within the shell-gland. The vagina has a large, elongate, setose dilation about 50  $\mu$  in diameter near the genital pore and bends at an obtuse angle median of this to extend posteriorly and medially to a receptaculum seminis about 14  $\mu$  in diameter. The uterus develops comparatively late, forming a median stem and lateral enlargements, the outlines of these later becoming quite indistinct. The eggs are 32 to 36  $\mu$  by 25 to 30  $\mu$  in diameter.

*Hosts.*—Primary: *Canis familiaris*, *C. lupus*, *C. aureus*, *C. dingo*, *C. mesomelas*, *Felis catus* (*F. c. domestica*), *F. concolor*. Secondary: *Homo sapiens*, *Bos taurus*, *Ovis aries*, *Capra hircus*, *Sus scrofa domestica*, *S. scrofa*, *Pithecius* species (*Simia cynomolgus*), *Pithecius silenus* (*Simia silenus*), *Simia sylvanus* (*Simia inuus*), *Ovis ammon*, *Camelus bactrianus*, *C. dromedarius*, *Giraffa* species (*Camelopardalis giraffa*), *Tetraceros quadricornis*, *Alces alces*, *Equus caballus*, *E. zebra*, *E. asinus*, *Tapirus indicus*, *Canis familiaris*, *Felis catus* (*F. c. domestica*), *F. pardus*, *Macropus major*, *Sciurus vulgaris*, *Mungos ichneumon* (*Herpestes ichneumon*), *Simia sylvanus* (*Inuus ecaudatus*), *Macropus giganteus*, *Ovis argali*, *Tapirus americanus*, *Oryctolagus cuniculus* (*Lepus cuniculus*).

*Location.*—In small intestine of primary host. In practically every organ and tissue of the secondary hosts.

*Localities.*—Cosmopolitan.

*Life history.*—The eggs produced by the adult worm in the intestine of the primary host pass out and are ingested by the secondary host in contaminated food or water, as a rule. In the digestive tract the embryo escapes from the shell and makes its way into the tissues. Here it develops into the larval stage, a bladderworm which may attain the size of a child's head, commonly called an echinococcus or hydatid, and known under numerous scientific names, largely based on morphological variations or hosts, and characterized by the formation of a laminated external layer and a delicate internal germinal layer. As a defense reaction against unfavorable conditions, the internal germinal membrane or scolices derived from it may give rise to internal daughter bladders, while proliferative elements in the cyst wall may form external daughter bladders. Daughter bladders may form grand-daughter bladders and any bladder of the series may form brood capsules containing scolices. When the larvae are ingested by the primary host, the heads contained in these brood capsules develop segments and form the strobilate worm.

This tapeworm must be comparatively common in dogs in some places in the United States, as the larval worms are not infrequently met with, especially in swine, in the meat inspection service of the United States Bureau of Animal Industry. However, the worm has only been reported by Curtice (1892*g*), who collected it in a dog from the pound in Washington, District of Columbia, and by Welch (1890*a*), who developed the adult worm in the dog as the result of feeding experiments. It has been collected from dogs in Alaska by Doctor Joss of the United States Bureau of Animal Industry, its occurrence here being reported by Ransom (1915).

Family MESOCESTOIDIDAE Fuhrmann, 1907.

*Synonym.*—Mesocestoidae Ariola, 1899.

*Family diagnosis.*—Taenioidea: Scolex without rostellum or hooks. Suckers unarmed. A single set of reproductive organs in each segment. Genital pores located on the ventral surface of the segment near the median line. Vagina opens in front of or beside the cirrus pouch. Eggs in gravid segments inclosed in a single thick-walled egg capsule. Adults in mammals and birds.

*Type-genus.*—*Mesocestoides* Vaillant, 1863.

Subfamily Mesocestoidinae Lühe, 1894.

*Subfamily diagnosis.*—Mesocestoididae: Characters of the family.

*Type-genus.*—*Mesocestoides* Vaillant, 1863.

Genus MESOCESTOIDES Vaillant, 1863.

*Synonyms.*—*Monodoridium* Walter, 1866; *Ptychophysa* Hamann, 1885*a*.

*Generic diagnosis.*—Mesocestoidinae: Genital pores near the anterior fourth of the ventral surface. The uterus forms an elongated median sac with wavy outline, irregularly constricted at certain points, the single egg capsule forming at the posterior portion of the uterus and of the segment.

*Type-species.*—*Mesocestoides ambiguus* Vaillant, 1863.

No key has been written for the species of *Mesocestoides*, for the reasons given in the discussion of *M. litteratus*.

MESOCESTOIDES LINEATUS (Goeze, 1782*a*) Railliet, 1893*a*.

*Synonyms.*—*Taenia lineata* Goeze, 1782*a*; *Halysis lineata* (Goeze, 1782*a*) Zeder, 1803*a*; *Taenia canis lagopodis* Rudolphi, 1810*a*; (?) *Mesocestoides litteratus* (Batsch, 1786*a*) Dolley, 1894*a*; *Taenia pseudoelliptica* Baillet, 1863*a*; *Taenia pseudo-cucumerina* Baillet, 1863*a*; *Ptychophysa lineata* (Goeze, 1782*a*) Hamann, 1885*a*.

*Specific diagnosis.*—*Mesocestoides*: The head is 600 to 900  $\mu$  in diameter, massive and somewhat flattened anteriorly. The rostellum is replaced by a slight central depression. The suckers are oval and display a widely opened longitudinal aperture. The neck is comparatively short and thick. The strobila measures from 30 cm. to 2.5 meters, and shows a feebly reddish color along the median line.



FIG. 59.—MESOCESTOIDES LINEATUS. PORTION OF STROBILA, SHOWING MATURE SEGMENTS. ENLARGED. AFTER NEUMANN, 1896.

The first segments are very short and indistinct. The following segments become square, with slightly convex lateral borders and with slightly prominent posterior angles (fig. 59). Segments become mature in the middle third of the strobila. The terminal segments measure 4 to 6 mm. long and 2 to 3 mm. wide, are shaped like melon seeds and are swollen in the median line by the ovoid uterine capsule filled with eggs. The male genitalia develop first.

*Male genitalia.*—Testes large and numerous (about 50) and scattered through the segment both median and lateral of the longitudinal excretory canals. Vas deferens describes numerous loops near the mid-dorsal line to the anterior extremity of the segment, where it turns abruptly and enters the cirrus pouch. The cirrus pouch is in the anterior portion of the segment, is well developed and prominent, piriform, and with its posterior aperture opening alternately, usually regularly but at times irregularly, a little to the right and to the left of the median line (fig. 59). The cirrus is from 50  $\mu$ . to 1 mm. long, swollen at its proximal extremity and commonly found protruded in mature segments.

*Female genitalia.*—The ovaries are located in the posterior fourth of the segment, and are irregularly spherical to oval. There are two vitellaria which are partly posterior of the ovaries and partly underneath the posterior portion of the ovaries. The vagina extends anteriorly and then returns in a sinuous curve posteriorly from the genital pore and on the side of the median line opposite to the cirrus pouch (fig. 60); it is without a receptaculum seminis. The uterus forms as an elongate sac in the median line, and presents

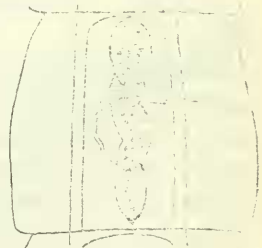


FIG. 60.—MESOCESTOIDES LINEATUS. MATURE SEGMENT. ENLARGED. AFTER NEUMANN, 1896.

anteriorly a curve to one side, the cirrus pouch always lying in the concavity of this curve, and the curve being alternately, regularly or irregularly, to the right or to the left (fig. 59). The posterior dilation of the uterus transforms into an egg capsule, the remains of the primitive uterus persisting as attached cord-like structures, a short one posteriorly and a longer, sinuous one anteriorly. The

eggs are ovoid, 40 to 60  $\mu$  long by 35 to 43  $\mu$  wide, and have two very thin shells.

*Hosts*.—Primary: *Canis familiaris*, *C. lagopus*, *Vulpes vulpes* (*V. vulgaris*), *Felis catus* (*F. domestica*), *Lynx nubicus* (*Lynxus nubicus*), *Lynx caracal*, *Felis sylvestris* (*Catus sylvestris*, *F. catus ferus*), ? *Mus musculus*. Secondary: Unknown.

*Location*.—Small intestine.

*Localities*.—France, Iceland, Germany, Italy, South Africa.

*Life history*.—Unknown.

MESOCESTOIDES LITTERATUS (Batsch, 1786a) Doiley, 1894a.

*Synonyms*.—*Taenia litterata* Batsch, 1786a; *Alyselminthus litteratus* (Batsch, 1786a) Zeder, 1880a; *Halysis litterata* (Batsch, 1786a) Zeder, 1803a; *Taenia utriculifera* Walter, 1866; *Ptychophysa litterata* (Batsch, 1786a) Loennberg, 1896a; *Mesocestoides utriculiferus* (Walter, 1866) Muehling, 1898b.

*Specific diagnosis*.—*Mesocestoides*: See *Mesocestoides lineatus*.

*Hosts*.—Primary: *Canis familiaris*, *Vulpes vulpes* (*Canis vulpes*, *Vulpes vulgaris*), *Martes foina* (*Mustela foina*), *Canis aureus*, *Felis sylvestris* (*Felis catus*). Secondary: Unknown.

*Location*.—Small intestine of primary host.

*Locality*.—Europe (Italy).

*Life history*.—Unknown.

Setti (1897b) notes the fact that a number of prominent helminthologists have regarded *Mesocestoides litteratus* as identical with *Mesocestoides lineatus*, and then takes up the arguments adduced by Zschokke (1888) and Condorelli (1891) and concludes that these two writers are in turn in disagreement as to the specific differences said to exist. He himself finds transitional and variable features in the descriptions and his material, which lead him to conclude that the two species are identical or of only varietal standing. The present writer is in no position to pass on the validity of the two species, but there appear to be no descriptions on which a working key could be constructed at present to differentiate the two species, if there are two. Under the circumstances the two names have been retained, but no attempt has been made to write a specific diagnosis, as any that have been seen would vary in no tangible essential feature from that of *M. lineatus*.

Family HYMENOLEPIDIDAE Railliet and Henry, 1909.

*Synonyms*.—Hymenolepidae Ariola, 1899; Echinocotylidae Ariola, 1899; Dilepinidae Fuhrmann, 1907.

*Family diagnosis*.—Taenioidea: Scolex with an armed rostellum or without rostellum. Hooks on rostellum not hammer-shaped. Suckers usually unarmed. A single, or less frequently a double, set

of reproductive organs in each segment. Genital pores marginal and bilateral, unilateral, or regularly or irregularly alternate. Eggs with thin transparent shells. Adults in mammals, birds, reptiles, and amphibia.

*Type-genus.*—*Hymenolepis* Weinland, 1858a.

#### Subfamily DIPYLIDIINAE Stiles, 1896.

*Synonyms.*—*Rhynchotaenia* Diesing, 1850a; *Malacolepidota* Weinland, 1858a; *Cystoideae* Leuckart, 1863; *Cystoidei* Leuckart, 1886; *Cystoidotaeniae* Railliet, 1885a; *Microtaeniae* Claus, 1891; *Dipylidiinae* Railliet, 1896; *Hymenolepinae* Perrier, 1897a; *Dilepininae* Fuhrmann, 1907; *Dilepidinae* Railliet and Henry, 1909.

*Subfamily diagnosis.*—*Hymenolepididae*: Rostellum armed or, less frequently, lacking. Suckers unarmed. A single set or, less frequently, a double set of reproductive organs in each segment. Uterus sac-like, simple or lobulated, or not persistent, breaking down into numerous egg capsules, each containing one or several eggs. Parauterine organs not developed. Adults in mammals, birds, and reptiles.

*Type-genus.*—*Dipylidium* Leuckart, 1863.

#### Genus DIPYLIDIUM Leuckart, 1863.

*Synonyms.*—*Taenia* Linnaeus, 1758a, part, of authors; *Taenia* (*Dipylidium*) Leuckart, 1863; *Alyselminthus* Weinland, 1858a, not Zeder, 1800a; *Cryptocystis* Villot, 1882; *Microtaenia* Claus, 1884; *Depylidium* Sonsino, 1895; *Dypilidium* Castellani and Chalmers, 1910; *Dipylidum* Daniels, 1910.

*Generic diagnosis.*—*Dipylidiinae*: Rostellum armed with several circlets of hooks which are of rose-thorn shape and usually provided with a discoidal base. Suckers unarmed. A double set of reproductive organs in each segment. Genital pores double and opposite. Testes very numerous, scattered throughout the entire medullary parenchyma. Vas deferens coiled; vesicula seminalis lacking. Gravid segments usually longer than broad. Uterus at first reticular, later breaking up into egg capsules, each containing one or more eggs. Adults in mammals and birds.

*Type-species.*—*Dipylidium caninum* (Linnaeus, 1758a) Railliet, 1892v.

#### KEY TO SPECIES OF DIPYLIDIUM.

1. Strobila not over 25 mm. long; rostellum with 4 circlets of hooks, the hooks 45  $\mu$  long and with a handle and guard; the cirrus pouch opens ventral of the vagina; 1 egg to each capsule.....*Dipylidium trinchesei*, p. 69.
- Strobila 5 cm. long or longer; hooks rose-thorn-shaped..... 2.
2. Head with 16 circlets of hooks; strobila 20 to 30 cm. long; 1 egg to each egg capsule.....*Dipylidium pasqualei*, p. 71.
- Heads with 3 to 14 circlets of hooks..... 3.

3. Head with 13 or 14 circlets of hooks; strobila 12 to 20 cm. long; 45 to 50 small testes; cirrus pouch 250 to 260  $\mu$  long and crossing the longitudinal excretory canals; vitellarium roughly spherical and smaller than the ovarian lobes; 1 large egg, 52 to 53  $\mu$  in diameter, in each egg capsule.

*Dipylidium chyzeri*, p. 68.

Head with not over 6 rows of hooks; 90 or more testes; 2 or more eggs in each capsule----- 4.

4. Heads with 6 circlets of hooks; strobila 10 to 23.5 cm. long; 130 to 140 testes; cirrus pouch extends to the longitudinal excretory canals; the median ovarian lobes crescentic, the lateral spherical; the vitellarium reniform and as large as an ovarian lobe; egg capsules with 2 to 15 eggs and at times extending lateral of the longitudinal excretory canals.

*Dipylidium scrocoronatum*, p. 65.

Heads with 3 to 5 circlets of hooks; cirrus pouch extends across the excretory canals regularly or occasionally; vitellarium smaller than the ovarian lobes or smaller than the median lobes----- 5.

5. Head with 5 circlets of hooks; strobila 5 to 11 cm. long; 90 to 100 large testes; cirrus pouch curved, convex posteriorly and extending distinctly across the longitudinal excretory canals; vitellarium smaller than the ovarian lobes; spindle-shaped receptaculum seminis present; vagina opens posterior of the cirrus pouch aperture; eggs 25  $\mu$  in diameter.

*Dipylidium oerleyi*, p. 63.

Head with 3 to 4 circlets of hooks; strobila 15 to 40 cm. long; 100 to 200 testes; cirrus pouch piriform and extending to, or occasionally across, the longitudinal excretory canals; no receptaculum seminis present, the oviduct showing a compensatory dilation; vagina opens ventral of the cirrus pouch aperture; eggs 43 to 50  $\mu$  in diameter----*Dipylidium caninum*, p. 73.

Parts of the above key are based on illustrations where the features in question are not specifically covered in the text, and therefore depend for their reliability on the accuracy of the illustrations and the constancy of the features covered.

DIPYLIDIUM OERLEYI von Rátz, 1900o.

*Specific diagnosis.*—*Dipylidium*: The head (fig. 61) is broad and club-shaped, and is 330  $\mu$  long and 390  $\mu$  wide; it tapers anteriorly to form a blunted cone; it is provided with a rostellum 67  $\mu$  long and 71  $\mu$  wide at the base, conical in shape, with a rounded apex, constantly retracted and lying in a deep depression. The rostellum bears 5 alternating circlets of hooks covering the lower portion of the cone, the tip of the cone being free from hooks; the hooks are of rose-thorn shape, with a somewhat bent ventral root and with a bevel-edged funnel-shaped base, so that the entire hook has the general form of a bent funnel. The rostellum is prolonged posteriorly to form a thick muscular mass, with a neck-like constriction anteriorly and terminating posteriorly in a large thick conical mass. The 4 suckers are oval and but slightly prominent. The neck is short and thick and diminishes in diameter posteriorly. The entire strobila is 5 to 11 cm. long and consists of 70 to 90 segments. The anterior segments are

very short. Posterior of these the segments lengthen and become almost square at a distance of 5 to 6 mm. posterior of the head. Posterior of these they become elongate, attaining a maximum length of 4 to 5 mm. and a maximum width of 2 mm. The posterior portion of each segment is longer than its anterior portion and extends a slight distance laterally to form the serrate margin. The terminal gravid segments are pale yellow and are sometimes piriform, the anterior portion being constricted and the posterior portion expanded. The genital primordia develop comparatively early and are recognizable 1 mm. behind the head in the twenty-fifth to the twenty-seventh segments, the male genitalia being the first to become visible. In mature segments (fig. 62) the genital pore lies posterior of the

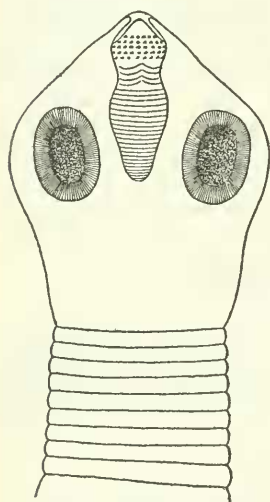


FIG. 61.—DIPYLIDIUM OERLEYI. HEAD. ENLARGED. AFTER VON RÄTZ, 1900a.

middle of the lateral margin, and is located in an inconspicuous depression. The excretory canals are visible just posterior of the head and become larger and wavy in the more developed segments.

*Male genitalia.*—

There are about 90 to 100 large testes, which fill the anterior and posterior portion of the field between the longitudinal ex-

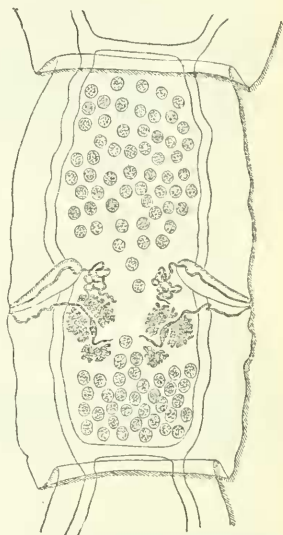


FIG. 62.—DIPYLIDIUM OERLEYI. MATURE SEGMENT. ENLARGED. AFTER VON RÄTZ, 1900a.

cretory canals; there are but few testes in the portion of the field near the female genitalia. The very much convoluted and looped vas deferens lies anterior of the ovaries and meets the cirrus pouch on the median side of the longitudinal canals. The cirrus pouch is elongate piriform, with the dilation toward the median portion of the segment; it is somewhat curved, with the convexity of the curve directed toward the posterior portion of the segment, and extends anteriorly and medially across the longitudinal canals.

*Female genitalia.*—The ovaries are in the middle field of the segment and for the most part are posterior of the genital pores. They are each composed of two lobes separated by the vagina, and each irregularly lobulated. The vitellaria are smaller than either of the two portions of each ovary and are likewise irregularly lobulated,



and are situated just posterior of the ovaries. The small shell gland is situated around the oviduct. The opening of the vagina is immediately behind that of the cirrus pouch; from here the vagina extends medially in a somewhat sinuous and curving course and swings posteriorly between the two lobes of the nearest ovary to a spindle-shaped receptaculum seminis in the comparatively wide clear field between these lobes. The uterus is only recognizable in the most developed segments in the form of a reticulum lying between

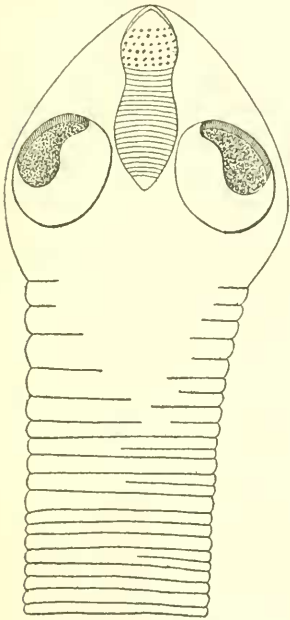


FIG. 63.—*DIPYLIDIUM SEXCORONATUM*. HEAD. ENLARGED. AFTER VON RÁTZ, 1900c.

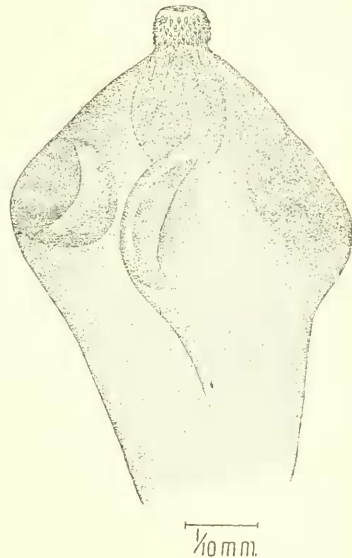


FIG. 64.—*DIPYLIDIUM SEXCORONATUM*. HEAD.

the testes. When full of eggs it bulges out in part and forms the egg capsules. The eggs lie in groups in these capsules and are round and  $25\ \mu$  in diameter.

*Host*.—Primary: *Felis catus* (*F. domestica*).

*Location*.—Small intestine.

*Locality*.—Hungary (Budapest).

*Life history*.—Unknown.

I am indebted for the translation of von Rátz's Hungarian description of this and the next species to the courtesy of Dr. Adolph Eichhorn, formerly of the United States Bureau of Animal Industry.

*DIPYLIDIUM SEXCORONATUM* von Rátz, 1900c.

*Specific diagnosis*.—*Dipylidium*: The head (figs. 63 and 64) is  $330\ \mu$  long and  $370\ \mu$  wide, oval in shape, and terminating conically

anteriorly. The conical rostellum (fig. 65) is usually retracted, and is 46  $\mu$  long and 54  $\mu$  wide at the base. The middle and lower thirds of the rostellum are covered with 6 circlets of hooks, which lie close together and almost cover this portion of the rostellum. My American specimens, as shown in figure 65, have 100 or more hooks. The hooks are rose-thorn shaped, those of the most anterior row being the largest and those of the posterior row being the smallest. The rostellum is continued posteriorly as a muscular mass, of which the anterior portion is thinner and the posterior portion is oval. The suckers are slightly prominent and are elongated longitudinally. The neck is very short and is scalloped by an imperfect transverse segmentation at the margin, these imperfect segmentations finally becoming complete and forming the more anterior segments. The

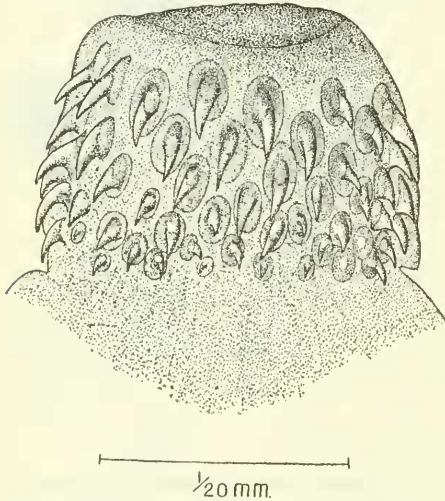


FIG. 65.—*DIPYLIDIUM SEXCORONATUM*. ROSTELLUM.

entire strobila is about 10 to 23.5 cm. long. The anterior segments are short and are followed by longer ones which become almost square about 1.5 cm. posterior of the head. About the middle of the strobila they are elongated longitudinally, becoming several times longer than wide. The longest segments are about at the union of the middle and posterior thirds of the strobila, and are 6 to 7 mm. long and 1 to 1.5 mm. wide. Posterior of this point they become shorter, wider, and thicker. The enlarged posterior margin of each segment forms a sort of collar about the smaller anterior margin of the succeeding segment. The primordium of the genital pore forms on young segments as a small protuberance, but in more mature segments this disappears and leaves instead a small depression, which is posterior of the middle of the lateral margin of the segment. The longitudinal excretory canals are very prominent, even in young segments, and later show as wide wavy canals; the transverse canals are likewise very wide and are situated at the union of adjacent segments.

*Male genitalia.*—The testes (fig. 66) are spherical, about 130 to 140 in number, and occupy nearly all the space between the longitudinal canals not occupied by the other genitalia; they are especially numerous in the middle and posterior portions of this field and leave a clear area in the anterior portion of the segment. The vas deferens

is much looped; it lies just anterior of the ovary and pursues a fairly straight course, aside from the loops, to the cirrus pouch. In young segments the cirrus pouch has the shape of an hourglass, widened proximally and distally and constricted medially; in mature segments it is piriform. It extends to the longitudinal excretory canal, but does not cross it.

*Female genitalia.*—Each ovary (fig. 66) consists of two distinct lobes, each of a loose, irregular structure, the lobe toward the median side of the segment following the convexity of the curve of the vagina in a roughly crescentic outline, and the one toward the lateral side of the segment lying in the concavity of the curve of the vagina in a roughly circular outline. The ovaries lie mostly posterior of the genital pores. The vitellaria are relatively compact reniform structures lying posterior of the ovaries, and each vitellarium is about as large as one of the two principal parts of each ovary. The shell-gland is a relatively large and compact reniform structure between the ovary and the vitellarium and displaced toward the median line. In young segments the vagina passes almost straight medially; in mature segments it is very slightly wavy in the lateral field of the segment and then curves posteriorly after crossing the excretory canal to form a spindle-shaped receptaculum seminis in the very narrow curved field between the two principal portions of each ovary. The uterus is only seen in later segments and is a fine tubular reticulum branching through the median field and especially distinct between the (? female) genitalia and posterior of these. After the constriction of some parts it forms egg capsules containing 2-3-8-15 eggs to a capsule. The eggs are spherical and are  $21\ \mu$  in diameter. The densest clumps of eggs are posterior of the oviducts, where the capsules form almost a connected network and may lie lateral of the longitudinal excretory canals.

*Host.*—Primary: *Canis familiaris*.

*Location.*—Small intestine.

*Localities.*—Hungary (Budapest); United States (Bethesda, Maryland; Detroit, Michigan).

*Life history.*—Unknown.

This species, reported for the first time from the United States by Hall (1917), the second record of its occurrence, was collected by the writer from a dog shipped from Fallon, Nevada, in 1910, and exam-

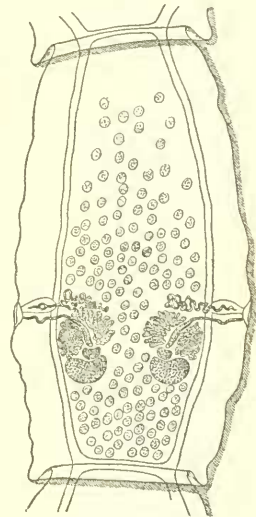


FIG. 66.—*DIPYLIDIUM SEXCORNATUM*. MATURE SEGMENT. ENLARGED. AFTER VON RÄTZ, 1900.

ined post mortem for parasites in 1913. In view of what we know of the length of life for dog cestodes, it is unlikely that the worms found were present when the dog arrived at Bethesda, Maryland. However, it is possible that the dog was infested with worms of this species and that the worms found were some from infestation due to eating intermediate hosts, presumably fleas or lice, as in *D. caninum*, which had been infected from the original worms. It is also possible



FIG. 67.—*DIPYLIDIUM CHYZERI*. HEAD. ENLARGED. AFTER VON RÄTZ, 1897b.

that the infestation originated entirely at Bethesda. A number of specimens were collected at Detroit from dogs which undoubtedly became infested in that locality.

Part of the specific description is based on von Rätz's illustrations, and so

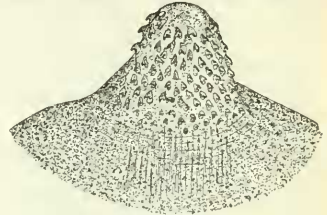


FIG. 68.—*DIPYLIDIUM CHYZERI*. ROSTELLUM. ENLARGED. AFTER VON RÄTZ, 1897b.

depends for its reliability on the accuracy of the illustrations and the constancy of the features illustrated.

*DIPYLIDIUM CHYZERI* von Rätz, 1897b.

*Specific diagnosis.*—*Dipylidium*: The head (fig. 67) is small, 352 to 432  $\mu$  in diameter, and conical. The rostellum (fig. 68) is conical,

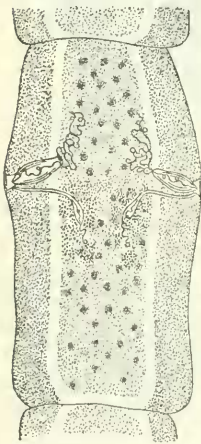


FIG. 69.—*DIPYLIDIUM CHYZERI*. MATURE SEGMENT. ENLARGED. AFTER VON RÄTZ, 1897b.

112  $\mu$  long, and terminates in a rounded tip. There are 13 to 14 circlets of hooks, forming diagonal rows toward the tip of the rostellum; these hooks are of rose-thorn shape with a flat basal portion attached at an angle. This basal part is formed by a long flat plate, thinned at both ends and bent at the anterior end, and the hook length proper is not over two-thirds the length of this basal portion. The largest hooks are near the tip of the rostellum, where they are 14  $\mu$  long and 5.5  $\mu$  thick; nearer the base they are 10.5 by 5  $\mu$ ; and those at the base are still smaller. The strobila is 12 to 20 cm. long and attains its maximum width, 1.4 to 1.6 mm., near the middle, at which point the segments are almost quadrate. The free gravid segments are 4.5 mm. long and 700 to 750  $\mu$  wide. The genital pores are anterior of the middle of the lateral margin of the seg-

ment. The longitudinal and transverse excretory canals are of about the same width.

*Male genitalia.*—The testes (fig. 69) are small, 45 to 50 in number, and are scattered at comparatively wide intervals throughout

the segment. There are apparently two or three vasa deferentia on each side of the segment (according to the illustration) and they extend in the median field parallel to the longitudinal excretory canals and just median of the canals. The cirrus pouch is large, 250 to 260  $\mu$  long by 120 to 130  $\mu$  wide, and piriform, and extends across the longitudinal canals into the median field.

*Female genitalia.*—Each ovary (fig. 69) is composed of two principal lobes, which are irregularly lobate elongated structures pressing close on each side of the vagina and receptaculum seminis, those on the median side lying on the convexity of the curve of the vagina and receptaculum seminis and having a roughly crescentic outline. The ovaries lie mostly posterior of the genital pores. The vitellarium is a roughly spherical mass lying posterior of the ovary and is smaller than either of the two main ovarian lobes. The shell-gland is very small and is between the vitellarium and the ovary. There is a large receptaculum seminis. Each of the uterine capsules contains only one large egg, 52 to 53  $\mu$  in diameter.

*Host.*—*Felis catus* (*Felis domestica*).

*Location.*—Intestine.

*Locality.*—Probably Hungary.

*Life history.*—Unknown.

Part of the above description is based on von Rátz's illustrations and so depends on the accuracy of the illustrations and the constancy of the features for its reliability, as noted in the foregoing species.

DIPYLIDIUM TRINCHESEI ReilHet, 1893a.

*Synonym.*—*Dipylidium trinchesei* Diamare, 1892a.

*Specific diagnosis.*—*Dipylidium*: Head (fig. 70) globular, with a relatively large imbutiform rostellum, the spherical anterior portion provided with four circlelets of about 80 hooks (fig. 71), the largest hooks being in the anterior circlelet and the smallest in the posterior circlelet, the largest attaining a length of 36  $\mu$  and a width of 47  $\mu$ ; the hooks of the first three rows are provided with a distinct handle and guard and a strongly curved blade. The suckers are orbicular and prominent. The neck is short. The entire strobila is very short, attaining a length of about 25 mm. The first segments are rectangular, with rounded margins. The genital primordia appear in the second or third segment and mature genitalia are present in the tenth segment. The mature segments

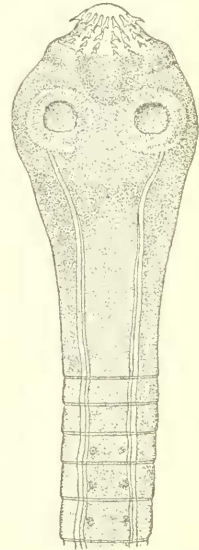


FIG. 70.—*DIPYLIDIUM TRINCHESEI*. ANTERIOR EXTREMITY (STROBILA). ENLARGED. AFTER DIAMARE, 1892a.

(fig. 72) are vase-shaped. Terminal gravid segments (fig. 73) become four times as long as wide. The genital pores are considerably anterior of the middle of the lateral margin of the segment, their position marking the point of maximum width of the vase-shaped segment.

*Male genitalia.*—Testes, judging from the figure, are few in number and scattered through the median field. Vas deferens in loops directed toward the anterior portion of the segment, and pigmented black. Cirrus pouch cylindrical, somewhat twisted, and opening ventral of the vagina; it apparently crosses the longitudinal canals in a wide curve, the convexity of the curve directed posteriorly.

*Female genitalia.*—Ovaries compact and globular to reniform. Vitellaria spherical. The vagina opens dorsal of the cirrus pouch

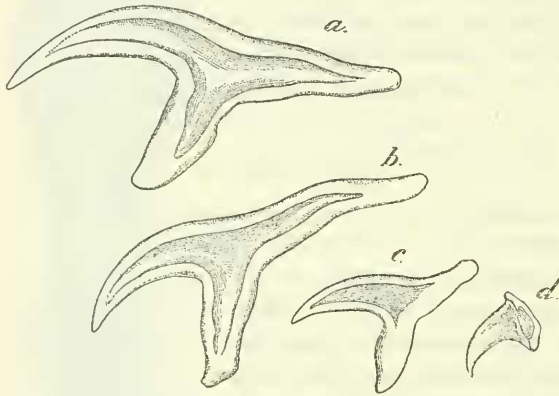


FIG. 71.—DIPYLIDIUM TRINCHESEI. HOOKS. *a*, HOOK FROM FIRST OR MOST ANTERIOR ROW; *b*, FROM SECOND ROW; *c*, FROM THIRD ROW; *d*, FROM FOURTH ROW. ENLARGED. AFTER DIAMARE, 1893b.

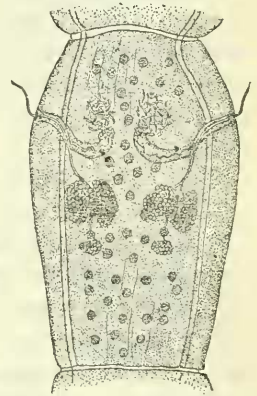


FIG. 72.—DIPYLIDIUM TRINCHESEI. MATURE SEGMENT. ENLARGED. AFTER DIAMARE, 1893b.

and passes medially to a large receptaculum seminis between the ovarian lobes. The egg capsules contain one egg each.

*Hosts.*—Primary: *Felis catus* (*F. domestica*). Secondary: *Zamenis viridiflavus*.

*Location.*—In small intestine of primary host. In cysts in the intestinal wall of the secondary host.

*Localities.*—Italy (Naples); Egypt (Alexandria).

*Life history.*—Diamare believes that *Cysticercus acanthotetra* Parona (1887) found in Sardinia in cysts in the intestinal wall of the snake *Zamenis viridiflavus*, is the larva of *Dipylidium trinchesei*. If this theory is correct, the worm is an accidental parasite of the cat, as cats are not generally in the habit of eating snakes, as Blanchard (1907) has noted. It might also be urged that there is probably comparatively little opportunity for the ingestion of the eggs of the adult worm by a secondary host like the snake except by

ingesting the primary host, a thing which might readily occur if the usual primary host is some small mammal. This would be a quite unusual and interesting case, where the infestation with a larval stage depended on the

ingestion of a primary host by a secondary host. But in view of the fact that the secondary host must in turn be eaten by the primary host, and in view of the fact that the only known intermediate hosts of a species of *Dipylidium* are insects, Diamare's hypothesis needs experimental verification before it can be accepted.

Diamare (1892*a*) first gave the number of hooks in this species as 65, but later (Diamare, 1893) gave the number as about 80.

**DIPYLIDIUM PASQUALEI**  
Diamare, 1893*a*.

*Specific diagnosis.*—*Dipylidium*: Head (fig 74) globular, 800 to 900  $\mu$  in diameter. The elongate, claviform rostellum is acuminate anteriorly and is armed

FIG. 73.—*DIPYLIDIUM TRINCHESEI*. GRAVID SEGMENT. ENLARGED. AFTER DIAMARE, 1893*b*.

with 16 circlets of hooks which have a discoid, almost circular base, and are 7  $\mu$  long and 8  $\mu$  wide, those of the last row being smaller. The suckers are rounded. The strobila is from 20 to 30 cm. long or longer. The genitalia develop rather late and mature segments (fig. 75) are still rather short and

quadrilateral. The genital pore

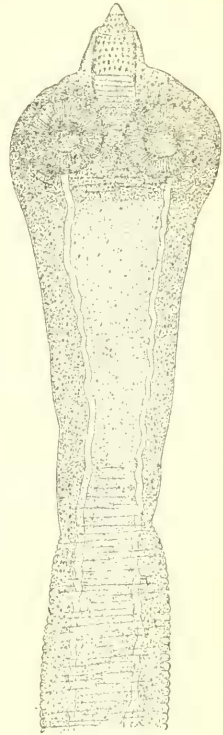
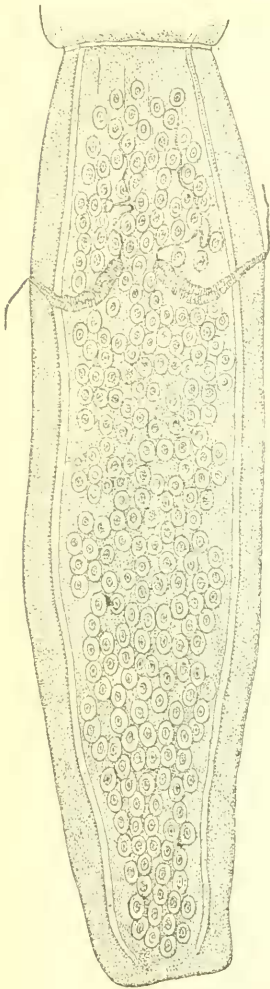


FIG. 74.—*DIPYLIDIUM PASQUALEI*. ANTERIOR PORTION OF STROBILA. ENLARGED. AFTER DIAMARE, 1893*b*.

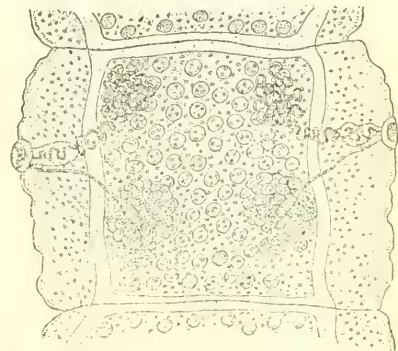


FIG. 75.—*DIPYLIDIUM PASQUALEI*. MATURE SEGMENT. ENLARGED. AFTER DIAMARE, 1893*b*.

is anterior of the middle of the lateral margin of the segment, and the cirrus pouch and vagina open at the same level. Gravid segments (fig. 76) are lanceolate in outline. The longitudinal excretory canals are very large, three times as large as in *Dipylidium caninum*. Calcareous corpuscles are numerous.

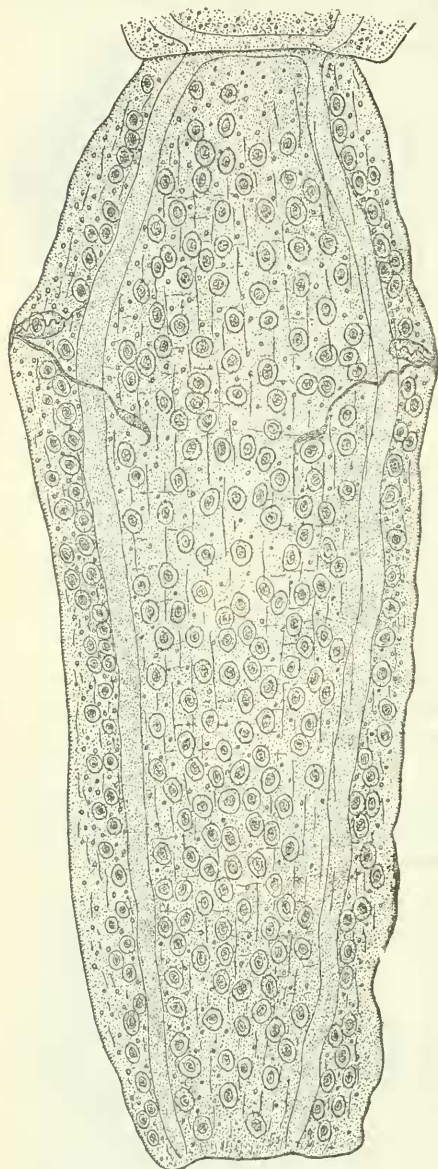


FIG. 76.—*DIPYLIDIUM PASQUALEI*. GRAVID SEGMENT. ENLARGED. AFTER DIAMARE, 1893b.

(fig. 76) are lanceolate in outline. The longitudinal excretory canals are very large, three times as large as in *Dipylidium caninum*. Calcareous corpuscles are numerous.

*Male genitalia*.—Judging from the illustration, the testes are large, few in number (about 50?) and uniformly distributed through the median field, not present lateral of the longitudinal excretory canals or of the ovaries. The vas deferens appears to be moderately looped distally, and coiled in the antero-lateral corner of the median field proximally. The cirrus pouch is figured as extending to the lateral canals or lying entirely lateral of these canals, but not crossing them.

*Female genitalia*.—The ovary is bilobed and branching. The vitellarium is bilobed. Shell gland (?). The vagina opens into a large fusiform receptaculum seminis. The egg capsules contain one egg each, and are distributed throughout the fields lateral of the longitudinal canal as well as median of it.

*Host*.—Primary: *Felis catus* (*F. domestica*).

*Location*.—Small intestine.

*Locality*.—Egypt (Alexandria).

*Life history*.—Unknown.

The figures for the size of the head are based on Diamare's statement that the head is twice as large as that of *D. echinorhynchoides*. The dimensions of the hooks are taken from Blanchard (1907).



## DIPYLIDIUM CANINUM (Linnaeus, 1758a) Railliet, 1892v.

*Synonyms*.—*Taenia canina* Linnaeus, 1758a; *T. moniliformis* Pallas, 1781, not Batsch, 1786a; *T. cucumerina* Bloch, 1782a; *T. cateniformis* Goeze, 1782a; *T. elliptica* Goeze, 1782a; *T. ellyptica* Batsch, 1786a; *T. cateniformis canina* Linnaeus of Gmelin, 1790a; *T. c. felis* Gmelin, 1790a; *Alyselminthus ellypticus* (Batsch, 1786a) Zeder, 1800a; *Taenia cunciceps* Zeder, 1800a; *Halysis ellyptica* (Batsch, 1786a) Zeder, 1803a; *Tenia canina* (Linnaeus, 1758a) van Beneden,

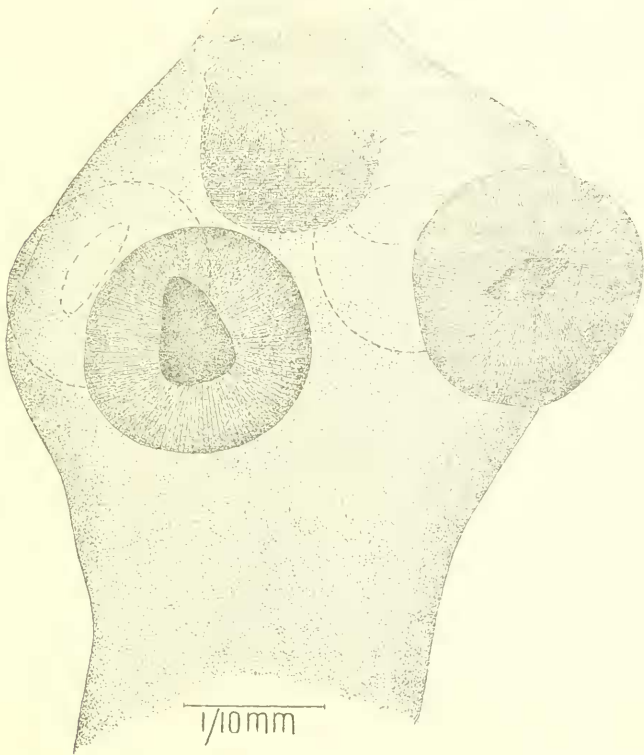


FIG. 77.—DIPYLIDIUM CANINUM. HEAD.

1861a; *T. cucumerina* (Bloch, 1782a) van Beneden, 1861a; *Taenia* (*Dipylidium*) *cucumerina* Bloch of Leuckart, 1863; *Cryptocystis trichodectis* Villot, 1882; *Dypylidium caninum* (Linnaeus, 1758a) von Rätz, 1897.

*Specific diagnosis*.—*Dipylidium*: Head (fig. 77) small and rhomboidal, 350 to 460  $\mu$  in diameter in a state of contraction. Rostellum claviform, 185  $\mu$  long in a state of complete evagination, 110 to 120  $\mu$  wide, and capable of retraction into a deep cephalic infundibulum. It is armed with three or, usually, four circlets of about 60 hooks

(fig. 78) of rose-thorn shape; the hooks of the most anterior row are the larger, 12 to 15  $\mu$  long, and those of the most posterior row the smallest, 5 to 6  $\mu$  long. The hooks are very easily lost and specimens are frequently found without any hooks or with only a few still in place. The suckers are very large and ellipsoidal. The neck is short and thin. The strobila is 15 to 40 cm. long and is composed of 80 to 120 segments. The segments are at first very short, then trapezoidal, and finally much longer than wide. Genitalia develop later. Mature

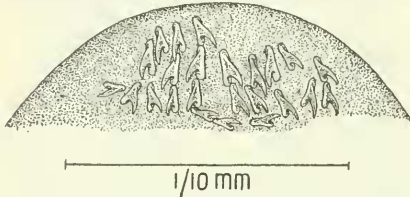


FIG. 78.—*DIPYLIDIUM CANINUM*. HOOKS.

and gravid segments (figs. 79 and 80) have distinctly convex lateral margins, giving the segments the characteristic cucumber-seed shape. Gravid segments are 8 to 11 mm. long and 1.5 to 3 mm. wide, and are often reddish in color. Genital pores are in the middle of the lateral margin of the segment or at times posterior of this. The lateral excretory canals are quite prominent.

*Male genitalia.*—Testes numerous, 100 to 200 in number, and occupying most of the parenchyma not occupied by the female genitalia. The vas deferens in mature segments extends anteriorly and laterally from the vicinity of the median lobe of each uterus, toward the cirrus pouch, only the final loop extending posteriorly to the cirrus pouch. The cirrus pouch may extend to the longitudinal excretory canal, but is usually entirely lateral of this; its aperture is dorsal to that of the vagina.

*Female genitalia.*—The two lobes of each ovary are very distinct, separated into lobules, and loosely formed; they are commonly said to be wing-shaped, but they are very irregular and difficult to characterize. The vitellarium is some distance posterior of the ovary and is irregular and very loosely lobulate; it is smaller than the median ovarian lobe, and equal to or smaller than the lateral lobe. The shell gland is between the ovary and the vitellarium. The vagina extends between the two lobes of each ovary and does not dilate to form a receptaculum seminis. The oviduct is dilated to compensate for the absence of a receptaculum seminis. Each egg capsule contains from 5 to 20 globular eggs, 43 to 50  $\mu$  in diameter, with thin shells and with an onchosphere 25 to 36  $\mu$  in diameter, provided with hooks 11 to 14  $\mu$  long.

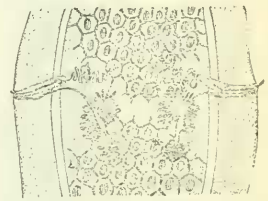


FIG. 79.—*DIPYLIDIUM CANINUM*. MATURE SEGMENT.  $\times 12.5$ . AFTER NEUMANN IN RAILLIET, 1893b.

*Hosts*.—Primary: *Canis familiaris*, *C. mesomelas*, *Felis sylvestris* (*F. catus*), *F. catus* (*F. catus domestica*), *F. maniculata*, *Homo sapiens*. Secondary: *Trichodectes canis*, *Ctenocephalus canis*, *Pulex irritans*.

*Location*.—In small intestine of primary host. In the visceral cavity of secondary hosts.

*Locality*.—Cosmopolitan.

*Life history*.—Eggs developed by the adult worm in the intestine of the primary host were once supposed to be ingested by the secondary hosts either on the skin of the primary host, where it was soiled by feces, or from the gravid segments direct. Melnikov (1869) has shown that *Trichodectes* eats the eggs as it feeds on the skin of the dog, but Joyeux (1916) has demonstrated that fleas ingest eggs while the fleas are larvae feeding on debris, the adult flea being unable to ingest a tapeworm egg. In the digestive tract of the secondary host the embryo escapes and makes its way to the visceral cavity where it develops into the tiny larva, called *Cryptocystis trichodectis*. When lice and fleas infested with these larvae are ingested by the primary host, the larval head passes to the intestine and gives rise to the strobilate worm.

SYNOPTICAL KEY.

The tapeworms of the dog, cat, and some related carnivores may be separated into the following groups and genera by the use of the appended key from Hall (1916*b*), (corrected for stenographic errors involving *Dipylidium pasqualei* and *D. chyzeri*), which is intended to designate the rela-

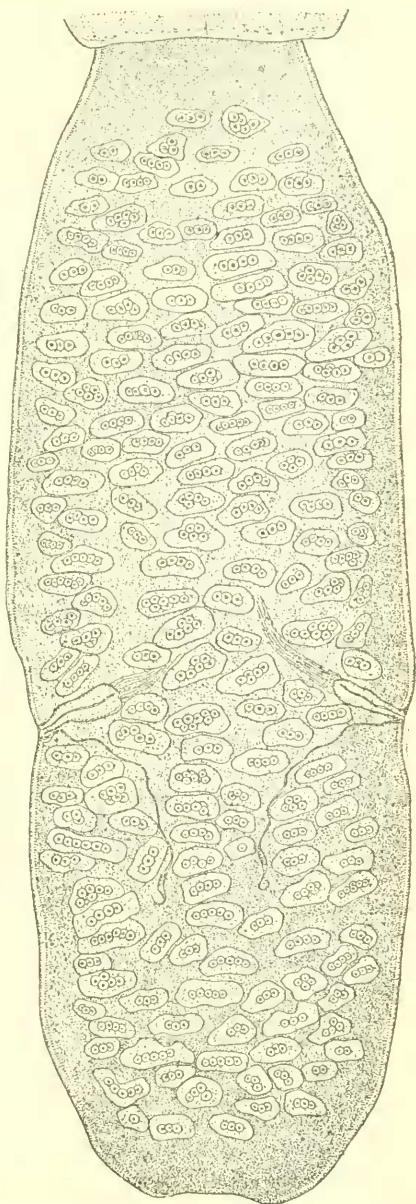


FIG. 30.—*DIPYLIDIUM CANINUM*. GRAVID SEGMENT. ENLARGED. AFTER DIAMARE, 1835b.

tions and importance of the tapeworms as well as to distinguish them from one another. The key does not cover the species in the family Diphylobothriidae.

1. Head provided with two slit-like suckers, and segments with a rosette-shaped uterus having a special aperture in the midventral line for the discharge of eggs. Larvae in fish.....Diphylobothriidae, p. 4.  
Head with four cup-shaped suckers.....2.
2. Follicular yolk glands in the lateral fields. Accidental in the dog.  
*Ophiotaenia punica*, p. 4.  
Yolk glands in median field, never in lateral fields.....3.
3. Genital pore located on the ventral surface near the median line. Eggs in gravid segments, contained in a single thick-shelled egg capsule.  
*Mesocestoides lineatus*, *Mesocestoides litteratus*  
(probably identical species), pp. 59, 61.  
Genital pore lateral. Eggs in gravid segments, contained in a uterus or in numerous egg capsules.....4.
4. Usually large forms. Genital pores irregularly alternate. Rostellum usually well developed and usually armed with a double crown of hooks, rarely with a single (?) crown of hooks or unarmed. Suckers unarmed. Uterus with a median stem and lateral branches. Eggs thick shelled...Taeniidae, 5, p. 5.  
Usually small forms. Genital pores single or double; if single, regularly or irregularly alternate. Rostellum present or absent; if present, armed with one to numerous rows of hooks. Suckers armed or unarmed. Uterus sac-like and persistent, or a single or double uterus with one or several parauterine organs, to which the eggs pass in the final stage of development. Eggs with thin, transparent shells.....Hymenolepididae, 19, p. 61.
5. Strobila less than 1 cm. long and composed of a head and 3 segments, only one of the segments being gravid at a time. Lateral uterine branches often quite indistinct. Yolk-gland globular. Larval stage an echinococcus with thick laminated wall, and developing brood capsules containing the larval scolices.....*Echinococcus granulatus*, p. 56.  
Strobila at least several centimeters long and composed of a head and numerous segments, from 10 to hundreds, with a number of segments usually gravid at one time. Lateral uterine branches usually distinct, at least in early stages of formation. Yolk gland posterior of ovaries and elongate or triangular, with one side parallel to the posterior margin of the segment. Larval stage a bladderworm with thin walls and never containing brood capsules.....6.
6. Strobila without a neck and with a double circle of many and very large hooks, the large hook over 300  $\mu$  long, or with only a single circle of hooks (?). Bladderworms, so far as known, with a small caudal bladder and with a long segmented structure connecting the bladder and head. Parasitic in Felidae.....7.  
Strobila with a neck and with a double circle of hooks, the large hook less than 300  $\mu$  long. Bladderworms with a caudal bladder, a head and a moderate-sized neck. Parasitic in Canidae.....10.
7. Rostellum with a single circle of hooks of rose-thorn-shape. Reported from *Lynx lynx* (*Felis lynx*).....*Taenia monostephanos*, p. 38.  
Rostellum with a double circle of hooks, the large hooks over 300  $\mu$  long...8.
8. Large hooks 60 to 74 in number; 320 to 355  $\mu$  long; the large hooks arranged so as to form in effect 2 circle of large hooks, being alternately nearer to the center of the rostellum and farther from it.  
*Taenia macrocystis*, p. 13.  
Large hooks not over 60 in number.....9.

9. Hooks 26 to 52 in number. Well developed sphincter vaginae.  
*Taenia taeniiformis*, p. 9.  
 Hooks 28 to 60 in number. Probably identical with the preceding species.  
*Taenia laticollis*, p. 8.
10. Vagina with a reflex curve near the lateral excretory canals. Large hooks 135 to 180  $\mu$  long and usually with a sinuous handle.  
*Multiceps*, 11, p. 39.  
 Vagina without a reflexed curve near the lateral canals.---*Taenia*, 13, p. 6.
11. Mature segments wider than long; the lateral margins of each segment often scalloped as a result of a number of constrictions or furrows passing around the segment transversely; the posterior margin of each segment prolonged posteriorly to overlap the anterior margin of the succeeding segment like a cuff. Small hook with short, blunt curving handle. Genital papilla very narrowly conical and in posterior half of segment, often near posterior margin. Larva a coenurus with daughter bladders, found in the connective tissue of rodents (including the Lagomorpha).  
*Multiceps serialis*, p. 51.  
 Mature segments longer than broad; the lateral margins of each segment smooth and not scalloped; the posterior margin of each segment prolonged very little or not at all to form a projection over the following segment. Small hooks with long slender handle. Genital papilla posterior of middle of segment but never near posterior margin. Larva a coenurus without daughter bladders, found in ungulates, especially ruminants -----12.
12. Small hook with long curving handle terminating in a blunt distal extremity. Large hook with tapering handle with sinuous outline. Testes do not extend posterior of the ovaries to the vicinity of the vitellarium or between the vitellarium and the ovaries. Larva a coenurus in the central nervous system of ungulates, especially ruminants.  
*Multiceps multiceps*, p. 40.  
 Small hook with long straight handle terminating in a blunt distal extremity. Large hook with the handle not tapering, and either straight and blunt or bent dorsally just at the tip. Testes extend posterior of the ovaries, almost to the vitellarium and between the vitellarium and the ovaries. Larva a coenurus in the central nervous system, lungs, parenchymatous organs and connective tissue of ruminants.  
*Multiceps gaigcri*, p. 45.
13. Forms in which the vagina crosses the ovary on the pore side in some segments, and forms in which the very large genital papilla is practically as long as the margin of the narrow segments. Bladderworms in the musculature of food animals-----14.  
 Forms in which the vagina does not cross the ovary on the pore side, and in which the genital papilla is never nearly as long as the margin of the segments-----15.
14. Gravid uterus with 20 to 25 lateral branches on each side of the median stem. Vagina crosses the ovary on the pore side in some segments. Genital papilla much shorter than the segment margin. Bladderworm in musculature of sheep-----*Taenia ovis*, p. 32.  
 Gravid uterus with not over 10 lateral branches on each side of the median stem. Vagina does not cross the ovary on the pore side of the segment. Genital papilla practically as long as the lateral margin of the narrow segments. Bladderworm in the musculature of reindeer.  
*Taenia krabbei*, p. 36.

15. Forms with the hooks from 170 to 294  $\mu$  long. Bladderworms attached to omenta, mesenteries, or peritoneal serosa.....16.  
Forms with the large hooks 135 to 145  $\mu$  long. Probably accidental parasites of the dog.....17.
16. Large hooks 225 to 294  $\mu$  long. Testes extend posterior of the vitellarium. Mature segments approximately square. Gravid segments with 8 to 14 lateral branches on each side. Vagina only slightly dilated and curved near margin of segment. Bladderworm in rabbits, rarely in mouse or beaver.....*Taenia pisiformis*, p. 22.  
Large hooks 170 to 224  $\mu$  long. Testes do not extend posterior of the vitellarium. Mature segments distinctly wider than long. Gravid segments with 5 to 10 lateral branches on each side. Vagina forms a sort of crescent by dilation and curvature near lateral margin of segment. Gravid segments with a median longitudinal groove terminating in a notch posteriorly. Bladderworm usually in ruminants, also reported from monkeys and rodents.....*Taenia hydatigena*, p. 28.
17. Guard of small hook twisted so that its flat surface tends to lie in the plane of the blade and handle.....*Taenia brachysoma*, p. 21.  
Guard of small hook not so twisted.....18.
18. Head acorn-shaped, with hooks far anterior of the suckers. Mature segments approximately square.....*Taenia balaniceps*, p. 16.  
Head not acorn-shaped, and hooks not far anterior of suckers. Mature segments distinctly broader than long.....*Taenia brauni*, p. 19.
19. Strobila not over 25 mm. long; rostellum with 4 circlets of hooks, the hooks 45  $\mu$  long and with a handle and guard; the cirrus pouch opens ventral of the vagina; 1 egg to each egg capsule.....*Dipylidium trinchesei*, p. 69.  
Strobila 5 cm. long or longer; hooks rose-thorn-shaped.....20.
20. Head with 16 circlets of hooks; strobila 20 to 30 cm. long; 1 egg to each egg capsule.....*Dipylidium pasqualei*, p. 71.  
Head with 3 to 14 circlets of hooks.....21.
21. Head with 13 to 14 circlets of hooks, strobila 12 to 20 cm. long; 45 to 50 small testes; cirrus pouch 250 to 260  $\mu$  long and crossing the longitudinal excretory canals; vitellarium roughly spherical and smaller than the ovarian lobes; 1 large egg, 52 to 53  $\mu$  in diameter, in each egg capsule.  
*Dipylidium chyzeri*, p. 68.  
Head with not over 6 rows of hooks; 90 or more testes; 2 or more eggs in each egg capsule.....22.
22. Head with 6 circlets of hooks; strobila 10 to 23.5 cm. long; 130 to 140 testes, cirrus pouch extends to the longitudinal excretory canals; the median ovarian lobes crescentic, the lateral spherical; the vitellarium reniform and as large as an ovarian lobe; capsules with 2 to 15 eggs and at times extending lateral of the longitudinal excretory canals.  
*Dipylidium sexocoronatum*, p. 65.  
Head with 3 to 5 circlets of hooks; cirrus pouch extends across the excretory canals regularly or occasionally; vitellarium smaller than the ovarian lobes or smaller than the median lobes.....23.
23. Head with 5 circlets of hooks; strobila 5 to 11 cm. long; 90 to 100 large testes; cirrus pouch curved, convex posteriorly, and extending distinctly across the longitudinal excretory canals; vitellarium smaller than the ovarian lobes; spindle-shaped receptaculum seminis present; vagina opens posterior of the cirrus pouch aperture; eggs 25  $\mu$  in diameter.  
*Dipylidium oerleyi*, p. 63.

Head with 3 to 4 circlets of hooks; strobila 15 to 40 cm. long; 100 to 200 testes; cirrus pouch piriform and extending to and occasionally across the longitudinal excretory canals; no receptaculum seminis present, the oviduct showing a compensatory dilation; vagina opens ventral of the cirrus pouch aperture; eggs 43 to 50  $\mu$  in diameter.

*Dipylidium caninum*, p. 73.

## LIST OF HOSTS.

The writer is indebted to Mr. Gerrit S. Miller, of the United States National Museum, for supplying the correct name in present usage for the various hosts involved in this paper. The names used by various authors which are no longer in good standing are covered in cross references.

## MAMMALS.

## MARSUPIALA.

## MACROPODIDAE.

- Macropus giganteus*:  
*Echinococcus granulosus*.  
*Macropus major*:  
*Echinococcus granulosus*.

## INSECTIVORA.

## TALPIDAE.

- Talpa europaea*:  
*Taenia taeniaeformis*.

## CHEIROPTERA.

## VESPERTILIONIDAE.

- Plecotus auritus*:  
*Taenia taeniaeformis*.

## CARNIVORA.

## CANIDAE.

- Canis aureus*:  
*Echinococcus granulosus*.  
*Mesocostoides litteratus*.  
*Canis dingoo*:  
*Echinococcus granulosus*.  
*Canis familiaris*:  
*Dipylidium caninum*.  
*Dipylidium sexcoronatum*.  
*Echinococcus granulosus*.  
*Mesocostoides lincatus*.  
*Mesocostoides litteratus*.  
*Multiceps gaigri*.  
*Multiceps multiceps*.  
*Multiceps serialis*.  
*Taenia balaniceps*.  
*Taenia brachysoma*.  
*Taenia brauni*.  
*Taenia hydatigena*.  
*Taenia krabbei*.  
*Taenia ovis*.  
*Taenia pisiformis*.

## CARNIVORA—Continued.

## CANIDAE—Continued.

- Canis latrans*:  
*Taenia pisiformis*.  
*Canis lupus*:  
*Echinococcus granulosus*.  
*Taenia hydatigena*.  
*Canis mesomelas*:  
*Dipylidium caninum*.  
*Echinococcus granulosus*.  
*Taenia hydatigena*.  
*Canis nebracensis*:  
*Multiceps multiceps*.  
*Taenia pisiformis*.  
*Canis lagopus*. See *Alopex lagopus*.  
*Canis vulpes*. See *Vulpes vulpes*.  
Saddle-backed jackal:  
*Taenia hydatigena*.  
*Alopex lagopus*:  
*Mesocostoides lincatus*.  
*Vulpes vulgaris*. See *Vulpes vulpes*.  
*Vulpes vulpes*:  
*Mesocostoides litteratus*.  
*Mesocostoides lincatus*.  
Fox:  
*Taenia pisiformis*.  
*Urocyon cinereo-argentatus*:  
*Taenia pisiformis*.  
MUSTELIDAE.  
*Galictis* species:  
*Taenia macrocystis*.  
*Martes foina*:  
*Mesocostoides litteratus*.

## MAMMALS—Continued.

## CARNIVORA—Continued.

## MUSTELIDAE—Continued.

- Mustela erminea*:  
*Taenia taeniaeformis*.  
*Mustela foina*. See *Martes foina*.  
*Putorius erminea*. See *Mustela erminea*.

## VIVERRIDAE.

- Mungos ichneumon*:  
*Echinococcus granulosus*.  
*Herpestes ichneumon*. See *Mungos ichneumon*.

## FELIDAE.

- Felis catus*: (See also *Felis sylvestris*.)  
*Dipylidium caninum*.  
*Dipylidium chyzeri*.  
*Dipylidium oerleyi*.  
*Dipylidium pasqualei*.  
*Dipylidium trinchesci*.  
*Mesocostoides lineatus*.  
*Taenia hydatigena*.  
*Taenia pisiformis*.  
*Taenia taeniaeformis*.  
*Echinococcus granulosus*.  
*Felis catus domestica*. See *Felis catus*.  
*Felis catus ferus*. See *Felis sylvestris*.  
*Felis concolor*:  
*Echinococcus granulosus*.  
*Taenia taeniaeformis*.  
*Felis domestica*. See *Felis catus*.  
*Felis cyra*:  
*Taenia taeniaeformis*.  
*Felis jaguarundi*. See *Felis yagouaroundi*.  
*Felis lynx*. See *Lynx lynx*.  
*Felis macroura*:  
*Taenia taeniaeformis*.  
*Felis maniculata*:  
*Taenia taeniaeformis*.  
*Dipylidium caninum*.  
*Felis melivora*:  
*Taenia taeniaeformis*.  
*Felis mitis*:  
*Taenia taeniaeformis*.  
*Felis onca*:  
*Taenia taeniaeformis*.  
*Felis pardus*:  
*Echinococcus granulosus*.

## CARNIVORA—Continued.

## FELIDAE—Continued.

- Felis* species:  
*Taenia macrocystis*.  
*Felis sylvestris*:  
*Dipylidium caninum*.  
*Mesocostoides lineatus*.  
*Mesocostoides litteratus*.  
*Taenia taeniaeformis*.  
*Felis* species:  
*Taenia macrocystis*.  
*Taenia taeniaeformis*.  
*Felis tigris*:  
*Taenia pisiformis*.  
*Felis yagouaroundi*:  
*Taenia macrocystis*.  
*Catus sylvestris*. See *Felis sylvestris*.  
*Lynx baileyi*:  
*Taenia macrocystis*.  
*Lynx canadensis*:  
*Taenia laticollis*.  
*Lynx caracal*:  
*Mesocostoides lineatus*.  
*Lynx lynx*:  
*Taenia laticollis*.  
*Taenia monostephanos*.  
*Lynx nubicus*:  
*Mesocostoides lineatus*.  
*Lynx rufa*. See *Lynx ruffus*.  
*Lynx ruffus*:  
*Taenia macrocystis*.  
*Lynx ruffus maculatus*:  
*Taenia balaniceps*.  
*Lynx rufus maculatus*. See *Lynx ruffus maculatus*.  
*Lynx uenta*. See *Lynx uinta*.  
*Lynx uinta*:  
*Taenia taeniaeformis*.  
*Lynchus nubicus*. See *Lynx nubicus*.

## RODENTIA.

## MURIDAE.

- "*Lemmus terrestris*."  
*Taenia taeniaeformis*.  
*Ondatra zibethica*:  
*Taenia taeniaeformis*.  
*Fiber zibethicus*. See *Ondatra zibethica*.  
*Arvicola amphibia*. See *Arvicola amphibius*.  
*Arvicola amphibius*:  
*Taenia taeniaeformis*.



## MAMMALS—Continued.

## RODENTIA—Continued.

## MURIDAE—Continued.

*Arvicola arvalis*. See *Microtus arvalis*.

*Microtus arvalis*:

*Taenia taeniaceiformis*.

*Epimys norvegicus*:

*Taenia taeniaceiformis*.

*Epimys rattus alexandrinus*:

*Taenia taeniaceiformis*.

*Epimys rattus rattus*:

*Taenia taeniaceiformis*.

*Mus musculus*:

*Mesocostoides lineatus*.

*Taenia pisiformis*.

*Taenia taeniaceiformis*.

*Mus rattus alexandrinus*. See

*Epimys rattus alexandrinus*.

*Mus tectorum*. See *Epimys rattus alexandrinus*.

## MYOCASTORIDAE.

? *Myocastor coypus*:

*Multiceps serialis*.

*Myopotamus coypus*. See

*Myocastor coypus*.

## SCIURIDAE.

*Sciurus carolinensis*:

*Multiceps serialis*.

*Sciurus cinereus*. See *Sciurus*

*niger neglectus*.

*Sciurus niger neglectus*:

*Taenia hydatigena*.

*Multiceps serialis*.

*Sciurus vulgaris*:

*Echinococcus granulosus*.

*Multiceps serialis*.

*Taenia hydatigena*.

*Sciurus rulpinus*. See *Sciurus*

*niger neglectus*.

## CASTORIDAE.

## Mountain beaver:

*Taenia pisiformis*.

## LAGOMORPHA.

## LEPORIDAE.

*Lepus americanus*:

*Taenia pisiformis*.

*Lepus brasiliensis*. See *Sylvilagus brasiliensis*.*Lepus californiensis*:

*Multiceps serialis*.

## LAGOMORPHA—Continued.

## LEPORIDAE—Continued.

*Lepus californicus deserticola*:

*Multiceps serialis*.

*Lepus californicus texianus*:

*Multiceps serialis*.

*Lepus californicus wallawalla*:

*Multiceps serialis*.

*Taenia pisiformis*.

" *Lepus callotis* " (New Mexico):

*Multiceps serialis*.

*Lepus cuniculus*. See *Oryctolagus cuniculus*.*Lepus cuniculus domesticus*.

See *Oryctolagus cuniculus*.

*Lepus cuniculus ferus*. See *Oryctolagus cuniculus*.*Lepus europaeus*:

*Multiceps serialis*.

*Taenia pisiformis*.

*Lepus mcarnsi*. See *Sylvilagus floridanus mcarnsi*.*Lepus palustris*. See *Sylvilagus palustris*.*Lepus sylvaticus*. See *Sylvilagus floridanus mallurus*.*Lepus texianus*. See *Lepus californicus texianus*.*Lepus timidus*: (See also *Lepus europaeus*.)

*Multiceps serialis*.

*Taenia pisiformis*.

*Lepus variabilis*. See *Lepus timidus*.*Oryctolagus cuniculus*:

*Echinococcus granulosus*.

*Multiceps serialis*.

*Taenia pisiformis*.

*Oryctolagus cuniculus domesticus*. See *Oryctolagus cuniculus*.*Oryctolagus cuniculus ferus*. See *Oryctolagus cuniculus*.*Sylvilagus auduboni baileyi*:

*Taenia pisiformis*.

*Sylvilagus brasiliensis*:

*Taenia macrocystis*.

*Taenia pisiformis*.

## MAMMALS—Continued.

## LAGOMORPHA—Continued.

## LEPORIDAE—Continued.

*Sylvilagus floridanus mallurus*:

*Taenia pisiformis*.

*Sylvilagus floridanus mearnsii*:

*Taenia pisiformis*.

*Sylvilagus mallurus*. See *Sylvilagus floridanus mallurus*.

*Sylvilagus nuttalli pinetis*:

*Taenia pisiformis*.

*Sylvilagus palustris*:

*Taenia pisiformis*.

## ARTIODACTYLA.

## CERVIDAE.

*Cervus axis*. See *Axis axis*.

*Cervus elaphus*:

*Taenia hydatigena*.

*Cervus unicolor*. See *Rusa unicolor*.

*Cervus virginianus*. See *Odocoileus americanus*.

*Odocoileus americanus*:

*Taenia hydatigena*.

*Odocoileus hemionus*:

*Taenia hydatigena*.

*Mazama rufa*:

*Taenia hydatigena*.

*Mazama nemorivaga*:

*Taenia hydatigena*.

*Cariacus macrotis*. See *Odocoileus hemionus*.

*Cariacus rufus*. See *Mazama rufa*.

*Cariacus simplicicornus*. See *Mazama nemorivaga*.

*Alces alces*:

*Echinococcus granulosus*.

*Taenia hydatigena*.

*Alces machlis*. See *Alces alces*.

*Rangifer tarandus*:

*Taenia hydatigena*.

*Taenia krabbei*.

*Rangifer terrae-novae*:

*Taenia hydatigena*.

*Rangifer novae-terrae*. See

*Rangifer terrae-novae*.

*Tarandus rangifer*. See *Rangifer tarandus*.

*Capreolus caprea*. See *Capreolus capreolus*.

## ARTIODACTYLA—Continued.

## CERVIDAE—Continued.

*Capreolus capreolus*:

*Taenia hydatigena*.

*Axis axis*:

*Taenia hydatigena*.

*Rusa unicolor*:

*Taenia hydatigena*.

Dulker:

*Taenia hydatigena*.

Springbok:

*Taenia hydatigena*.

Rooi reebok:

*Taenia hydatigena*.

Columbia deer:

*Taenia hydatigena*.

Bharrel:

*Taenia hydatigena*.

Chamois:

*Multiceps multiceps*.

Mouflon:

*Multiceps multiceps*.

Gazelle:

*Multiceps multiceps*.

Antelope:

*Multiceps multiceps*.

African antelope:

*Multiceps multiceps*.

## BOVIDAE.

*Bos taurus*:

*Echinococcus granulosus*.

*Multiceps multiceps*.

*Taenia hydatigena*.

*Bubalis* species:

*Multiceps multiceps*.

*Capra hircus*:

*Echinococcus granulosus*.

*Multiceps gaigeri*.

*Multiceps multiceps*.

*Taenia hydatigena*.

*Taenia oris*.

*Kobus ellipsiprymus*:

*Taenia hydatigena*.

*Ozanna equina*:

*Multiceps multiceps*.

*Hippotragus equinus*. See

*Ozanna equina*.

*Gazella dorcas*:

*Taenia hydatigena*.

*Gazella euchore*. See *Antidorcas euchore*.

## MAMMALS—Continued.

## ARTIODACTYLA—Continued.

## BOVIDAE—Continued.

- Antidorcas euchores:*  
*Taenia hydatigena.*
- Oryx beisa:*  
*Taenia hydatigena.*
- Oryx leucoryx:*  
*Taenia hydatigena.*
- Ovis ammon:*  
*Echinococcus granulosus.*
- Ovis argali:*  
*Echinococcus granulosus.*  
*Taenia hydatigena.*
- Ovis aries:*  
*Echinococcus granulosus.*  
*Multiceps multiceps.*  
*Taenia hydatigena.*  
*Taenia oris.*
- Ovis mexicana:*  
*Taenia hydatigena.*
- Ovis musimon:*  
*Taenia hydatigena.*
- Rupicapra rupicapra:*  
*Taenia hydatigena.*
- Rupicapra tragus.* See *Rupicapra rupicapra.*
- Saiga tartarica:*  
*Taenia hydatigena.*
- Tetraceros quadricornis:*  
*Echinococcus granulosus.*

## SUIDAE.

- Phachochocrus athiopicus:*  
*Taenia hydatigena.*
- Phachochocrus africanus:*  
*Taenia hydatigena.*
- Potamochoerus koiropotamus.*  
*Taenia hydatigena.*
- Potamochoerus porcus.* See *Potamochoerus koiropotamus.*
- Sus scrofa:*  
*Echinococcus granulosus.*  
*Taenia hydatigena.*
- Sus scrofa domestica:*  
*Echinococcus granulosus.*  
*Taenia hydatigena.*

## GIRAFFIDAE.

- Giraffa* species:  
*Echinococcus granulosus.*
- Camelopardalis giraffa.* See *Giraffa* species.

## ARTIODACTYLA—Continued.

## CAMELIDAE.

- Camelus bactrianus:*  
*Echinococcus granulosus.*
- Camelus dromedarius:*  
*Echinococcus granulosus.*

## PERISSODACTYLA.

## EQUIDAE.

- Equus asinus:*  
*Echinococcus granulosus.*
- Equus caballus:*  
*Echinococcus granulosus.*  
*Multiceps multiceps.*
- Equus zebra:*  
*Echinococcus granulosus.*

## TAPIRIDAE.

- Tapirus americanus:*  
*Echinococcus granulosus.*
- Tapirus indicus:*  
*Echinococcus granulosus.*

## PRIMATES.

## HOMINIDAE.

- Homo sapiens:*  
*Dipylidium caninum.*  
*Echinococcus granulosus.*  
*Multiceps multiceps.*

## IASIOPYGIDAE.

- Simia cynomolgus.* See *Pithecus* species.
- Simia sylvanus:*  
*Echinococcus granulosus.*  
*Taenia hydatigena.*
- "*Simia faunus:*"  
*Taenia hydatigena.*
- Simia inuus.* See *Simia sylvanus.*
- Simia silenus.* See *Pithecus silenus.*
- Papio maimon:*  
*Taenia hydatigena.*
- Pithecus* species:  
*Echinococcus granulosus.*  
*Taenia hydatigena.*
- Pithecus silenus:*  
*Echinococcus granulosus.*
- Macacus cynomolgus.* See *Pithecus* species.
- Macacus inuus.* See *Simia sylvanus.*

## MAMMALS—Continued.

## PRIMATES—Continued.

## LASIOPYGIDAE—Continued.

*Presbytis entellus:**Taenia hydatigena.**Semnopithecus entellus.* See*Presbytis entellus.**Semnopithecus cynosurus.* See*Lasiopyga cynosura.**Lasiopyga cynosura:**Taenia hydatigena.**Lasiopyga mona:**Taenia hydatigena.*

## PRIMATES—Continued.

## LASIOPYGIDAE—Continued.

*Lasiopyga sabaeus:**Taenia hydatigena.**Cercopithecus mona.* See*Lasiopyga mona.**Cercopithecus sabaeus.* See*Lasiopyga sabaeus.**Inuus caudatus.* See *Simia**sylvanus.*

## REPTILES.

## SERPENTES.

## COLUBRIDAE.

*Zamenis viridiflavus:**Dipylidium trinchesci.*

## INSECTS.

## SIPHONAPTERA.

## PULICIDAE.

*Pulex irritans:**Dipylidium caninum.**Ctenocephalus canis:**Dipylidium caninum.*

## MALLOPHAGA.

## TRICHODECTIDAE.

*Trichodectes canis:**Dipylidium caninum.*

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